# AlazarTech SDK
# Programmer's Guide

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# 1 Getting Started

## 1.1 Introduction

AlazarTech supplies device drivers for Windows and Linux that allow software to configure AlazarTech digitizers, and transfer sample data from the digitizer to application buffers.

The AlazarTech software developer's kit (ATS-SDK) includes header and library files required to call functions exported by these device drivers in user written applications, as well as documentation and sample code describing how to use these functions.

This document is a part of the ATS-SDK. It describes how to call functions exported by AlazarTech device drivers to control one or more digitizer boards. It is divided into the following sections:

- A programming guide that describes how to configure, and acquire data from, digitizer boards.
- A reference guide that describes the functions exported by the device drivers.

To get the most from your AlazarTech digitizer:

- Read the user manual supplied their digitizer board. It provides an overview of the digitizer hardware, as well as detailed specifications.
- Read the "Programmer's guide" section of this document. It describes how to program the digitizer hardware to make an acquisition, and to transfer sample data into application buffers.
- Browse the SDK sample programs. They include sample code that demonstrates how to make many types of acquisitions supported by the digitizer.

Note that this document includes descriptions of board specific features and options that may not be available on your digitizer board. Please refer your board's user manual for its specifications.

## 1.2 Programming environments

### 1.2.1 C/C++ Linux

C/C++ developers under Linux should include the following header files in source files that use functions exported by the ATS-SDK library.

```
#include "AlazarError.h"
#include "AlazarApi.h"
#include "AlazarCmd.h"
```

These modules should also link against libPlxApi.so.

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The RPM package for Linux installs the header files in "%ATS_SDK_DIR%\Include", and the library files in "%ATS_SDK_DIR%\Library", where %ATS_SDK_DIR% defaults to "/usr/local/AlazarTech".

### 1.2.2 C/C++ Windows

C/C++ developers should include the following header files in source files that use functions exported by the API library.

```
#include "AlazarError.h"
#include "AlazarApi.h"
#include "AlazarCmd.h"
```

These applications should also link against the 32- or 64-bit version of ATSApi.lib, as required.

The SDK setup program installs the header files in "Samples\Include", and the library files in "Samples\Library".

### 1.2.3 C#

C# developers should either:

- Add the file AlazarApi.cs to their project; or
- Add a reference to AlazarApiNet.dll to their project.

The ATS-SDK includes a wrapper class that declares many of the constants and unmanaged functions exported by AlazarTech device drivers. This class is provided both as a C# source file (AlazarApi.cs), and as a compiled assembly (AlazarApiNet.dll).

The SDK setup program copies AlazarApi.cs to the "Samples_CSharp\AlazarApiNet\AlazarApiNet" directory and AlazarApiNet.dll to the "Samples_CSharp" directory.

Note that you can use the solution "Samples_CSharp\AlazarApiNet" to build AlazarApiNet.dll from AlazarApi.cs.

### 1.2.4 LabVIEW

LabVIEW developers can:

- Use ATS-VI for LabVIEW to configure and acquire data from AlazarTech digitizers directly from LabVIEW.
- Use the ATS-SDK to create a Windows DLL (or Linux shared library) to configure and acquire data from AlazarTech digitizers, and call functions exported by this DLL from LabVIEW applications using the "Call Library" function.

ATS-VI for LabVIEW provides a rich set of sub-vis and sample applications. The VIs are divided into layers: lowest-level sub-VIs call functions exported by AlazarTech drivers to configure and acquire data from AlazarTech digitizers; higher-level sub-VIs add data clusters, type definitions, and utility sub-VIs to organize calls the lowest-level sub-VIs;

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and sample applications demonstrate how to configure and acquire data from AlazarTech digitizers using lower level sub-VIs.

This manual documents the functions called by the lowest-level sub-VIs. Please see the ATS-VI for LabVIEW User Manual for more information about higher level sub-VIs and sample applications in the ATS-VI for LabVIEW.

### 1.2.5 MATLAB

MATLAB developers can:

- Call functions exported by AlazarTech drivers DLL directly from MATLAB scripts and functions using the MATLAB 'calllib' function.
- Create a MEX-file dynamic link library to configure and acquire data from the digitizer, and call the mexFunction entry point of the DLL from MATLAB.

ATS-SDK samples demonstrate how to use the MATLAB "calllib" interface. They use prototype files to load the AlazarTech driver library into memory, and call AlazarDefs.m to define constants used by the AlazarTech library.

The ATS-SDK setup program installs AlazarDefs.m, alazarLoadLibrary.m, and other helper functions in the "Samples_MATLAB\Include" folder.

### 1.2.6 Visual Basic 6

Visual Basic programmers should include the module ATSApiVB.bas in their projects. It provides a Visual Basic interface to the many of the constants and functions used by AlazarTech device drivers.

The ATS-SDK setup program installs this module in the "Samples_VB" folder.

### 1.2.7 Visual Basic .NET

VB.NET programmers should include a reference to "Samples_CSharp\AlazarApiNet.dll" in their solutions. This assembly provides a .NET interface to the functions and constants defined in the ATS-SDK.

The ATS-SDK does not currently include VB.NET sample code. See the C# samples for .NET sample code.

### 1.2.8 C++/CLI

C++/CLI programmers should include a reference to "Samples_CSharp\AlazarApiNet.dll" in their solutions. This assembly provides a .NET interface to the functions and constants defined in the ATS-SDK.

The ATS-SDK does not currently include C++/CLI sample code. See the C# samples for .NET sample code.

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## 1.3 Sample code

ATS-SDK includes sample programs that demonstrate how to configure and acquire data from AlazarTech digitizers.

The SDK setup program installs the sample programs to "C:\AlazarTech\ATS-SDK\%API_VERSION%" under Microsoft Windows, and "/usr/local/AlazarTech" under Linux. See the "ReadMe.htm" file in the ATS-SDK base directory for a description of the samples included.

Sample programs are available for the following programming environments in the following sub-directories:

| Language | Sub-directory |
|---|---|
| C/C++ | Samples |
| C# | Samples_CSharp |
| MATLAB | Samples_MATLAB |
| Visual Basic | Samples_VB |

Note that the sample programs contain many parameters that should be modified. These lines of code are preceded by "TODO" comments. Please search for these lines and modify them as required for your application.

Many sample programs require a trigger input. These sample programs configure a board to trigger when a signal connected to its CH A rises through 0V. Before running these samples, connect a ±500 mV (1Vpp) 1 KHz sine waveform from a function generator to the CH A connector, or modify trigger parameters as required. If an appropriate trigger signal is not supplied, these samples will fail with an acquisition timeout error.

## 1.4 Contacting us

Contact us if you have any questions or comments about this document, or the sample code.

| | |
|---|---|
| Web | http://www.alazartech.com |
| Email | mailto:support@alazartech.com |
| Phone | +1-514-426-4899 |
| Fax | +1-514-426-2723 |
| Mail | Alazar Technologies Inc.<br>6600 Trans-Canada Highway, Suite 310<br>Pointe-Claire, QC<br>Canada H9R 4S2 |

Note that you can download the latest drivers and documentation from our web site.
http://www.alazartech.com/support/downloads.htm

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# 2 Programmer's Guide

## 2.1 Addressing a board

### 2.1.1 Getting a board identifier

AlazarTech organizes its digitizer boards into "board systems". A board system is a group of one or more digitizer boards that share trigger and clock signals. Two or more boards form a board system when they are connected together using an AlazarTech SyncBoard. All of the channels in a board system trigger and and are sampled simultaneuously.

ATS-SDK assigns a "system identifier" number to each board system. The first system detected is assigned system ID number of 1.

ATS- SDK assigns a "board identifier" number to each board in a board system. This number uniquely identifies a board within its board system.

- If a digitizer board is not connected to any other boards using a SyncBoard, then the SDK assigns it a board ID of 1.
- If two or more boards are connected together using a SyncBoard, then the SDK assigns each board an ID number that depends on how the board is connected to the SycnBoard. The board connected to the "master" slot on the SyncBoard is the master board in the board system, and is assigned a board ID number of 1.

Call the AlazarNumOfSystems function to determine the number of board systems detected by the SDK, and call the AlazarBoardsInSystemBySystemID function to determine the number of boards in the board system specified by its system identifier.

The following code fragment lists the system and board identifiers of each board detected by the device drivers.

```
U32 systemCount = AlazarNumOfSystems();
for (U32 systemId = 1; systemId <= systemCount; systemId++)
{
   U32 boardCount = AlazarBoardsInSystemBySystemID(systemId);
   for (U32 boardId = 1; boardId <= boardCount; boardId++)
   {
      printf("Found SystemID %u Board ID = %u\n",
         systemId, boardId);
   }
}
```

### 2.1.2 Getting a board handle

ATS-SDK associates a handle with each digitizer board.

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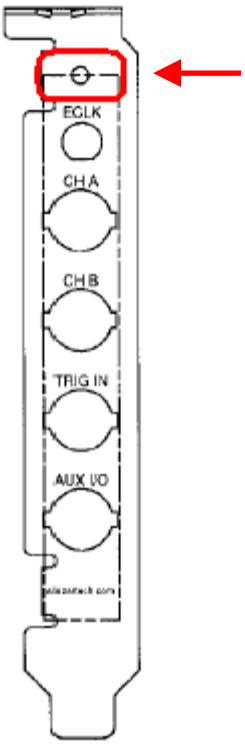
Most ATS-SDK functions require a board handle as a parameter. For example, the AlazarSetLED function allows an application to control the LED on the PCI/PCIe mounting bracket of a board specified by its handle.

**Figure 2-1 PCI/PCIe mounting bracket LED**




Use the AlazarGetBoardBySystemID API function to get a handle to a board specified by its system identifier and board identifier numbers.

### 2.1.2.1 Single board installations

If only one board is installed in a computer, ATS-SDK assigns it system ID 1 and board ID 1. The following code fragment gets a handle to such a board, and uses this handle to toggle the LED on the board's PCI/PCIe mounting bracket.

```
// Select a board
U32 systemId = 1;
U32 boardId = 1;

// Get a handle to the board
HANDLE boardHandle = AlazarGetBoardBySystemID(systemId, boardId);

// Toggle the LED on the board's PCI/PCIe mounting bracket
AlazarSetLED(boardHandle, LED_ON);
Sleep(500);
AlazarSetLED(boardHandle, LED_OFF);
```

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#### 2.1.2.2 Multiple board installations

If more than one board is installed in a PC, the boards are organized into board systems, and are assigned system and board identifier numbers. The following code fragment demonstrates how to obtain a handle to each board in such an installation, and use the handle to toggle the LED on the board's PCI/PCIe mounting bracket.

```
U32 systemCount = AlazarNumOfSystems();
for (U32 systemId = 1; systemId <= systemCount; systemId++)
{
   U32 boardCount = AlazarBoardsInSystemBySystemID(systemId);
   for (U32 boardId = 1; boardId <= boardCount; boardId++)
   {
      printf("SystemID %u Board ID = %u\n", systemId, boardId);

      // Get a handle to the board
      HANDLE handle = AlazarGetBoardBySystemID(systemId, boardId);

      // Toggle the LED on the board's PCI/PCIe mounting bracket
      AlazarSetLED(handle, LED_ON);
      Sleep(500);
      AlazarSetLED(handle, LED_OFF);
   }
}
```

#### 2.1.2.3 System handles

Several ATS-SDK functions require a "system handle". A system handle is the handle of the master board in a board system.

- If a board is not connected to other boards using a SyncBoard, then its board handle is the system handle.
- If a board is connected to other boards using a SyncBoard, then the board that is connected to the master connector on the SyncBoard is the master board, and its board handle is the system handle.

### 2.1.3 Closing a board handle

ATS-SDK maintains a list of board handles in order to support master-slave board systems. The SDK creates board handles when it is loaded into memory, and destroys these handles when it is unloaded from memory. An application should not need to close a board handle.

### 2.1.4 Using a board handle

ATS-SDK includes a number of functions that return information about a board specified by its handle.

These functions include:

| | |
|---|---|
| AlazarGetBoardKind | Get a board's model from its handle. |
| | |
| AlazarGetChannelInfo | Get the number of bits per sample, and on-board memory size in samples per channel. |

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| | |
|---|---|
| AlazarGetCPLDVersion | Get the CPLD version of a board. |
| AlazarGetDriverVersion | Get the driver version of a board. |
| AlazarGetParameter | Get a board parameter as a signed 32-bit value. |
| AlazarGetParameterUL | Get a board parameter as an unsigned 32-bit value. |
| AlazarQueryCapability | Get a board capability as an unsigned 32-bit value. |

The sample program "%ATS_SDK_DIR%\Samples\AlazarSysInfo" demonstrates how get a board handle, and use it to obtain board properties.

The API also exports functions that use a board handle to configure a board, arm it to make an acquisition, and transfer sample data from the board to application buffers. These topics are discussed in the following sections.

## 2.2 Resetting a board

The ATS-SDK resets all digitizer boards during its initialization procedure.

This initialization procedure automatically runs when the API library is loaded into memory.

- If an application statically links against the API library, the API resets all boards when the application is launched.
- If an application dynamically loads the API library, the API resets all boards when the application loads the API into memory.

Note that when an application using the API is launched, all digitizer boards are reset. If one application using the API is running when a second application using the API is launched, configuration settings written by the first application to a board may be lost. If a data transfer between the first application and a board was in progress, data corruption may occur.

## 2.3 Configuring a board

Before acquiring data from a board system, an application must configure the timebase, analog inputs, and trigger system settings of each board in the board system.

### 2.3.1 Timebase

The timebase of the ADC converters on AlazarTech digitizer boards may be supplied by:

- Its on-board oscillators.
- A user supplied external clock signal.
- An on-board PLL clocked by a user supplied 10 MHz reference signal.

#### 2.3.1.1 Internal clock

To use on-board oscillators as a timebase, call AlazarSetCaptureClock specifying INTERNAL_CLOCK as the clock source identifier, and select the desired sample rate with a sample rate identifier appropriate for the board.

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The following code fragment shows how to select a 10 MS/s internal sample rate.

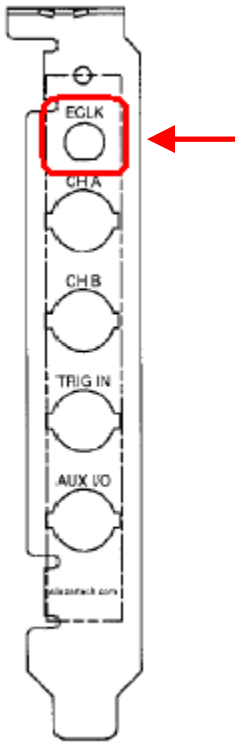
```
AlazarSetCaptureClock(
   handle,                 // HANDLE -- board handle
   INTERNAL_CLOCK,         // U32 -- clock source Id
   SAMPLE_RATE_10MSPS,     // U32 -- sample rate Id or value
   CLOCK_EDGE_RISING,      // U32 -- clock edge Id
   0                       // U32 -- decimation
   );
```

See AlazarSetCaptureClock or the board reference manual for a list of sample rate identifiers appropriate for a board.

### 2.3.1.2 External clock

AlazarTech boards optionally support using a user-supplied external clock signal input to the ECLK connector on its PCI/PCIe mounting bracket to clock its ADC converters.

**Figure 2-2 External clock connector on PCI/PCIe mounting bracket.**




To use an external clock signal as a timebase, call AlazarSetCaptureClock specifying SAMPLE_RATE_USER_DEF as the sample rate identifier, and select a clock source identifier appropriate for the board model and the external clock properties.

The following code fragment shows how to configure an ATS460 to acquire at 100 MS/s with a 100 MHz external clock.

```
AlazarSetCaptureClock(
```

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```
    handle,                 // HANDLE -- board handle
    FAST_EXTERNAL_CLOCK,    // U32 -- clock source Id
    SAMPLE_RATE_USER_DEF,   // U32 -- sample rate Id or value
    CLOCK_EDGE_RISING,      // U32 -- clock edge Id
    0                       // U32 -- decimation
    );
```

See the board reference manual for the properties of an external clock signal that are appropriate for a board, and AlazarSetCaptureClock for a list of external clock source identifiers.

#### 2.3.1.3 External clock level

Some boards allow adjusting the comparator level of the external clock input receiver to match the receiver to the clock signal supplied to the ECLK connector.

If necessary, call AlazarSetExternalClockLevel to set the relative external clock input receiver comparator level, in percent.

```
AlazarSetExternalClockLevel(
    handle,                 // HANDLE -- board handle
    level_pecent,           // float -- exernal clock level in percent
    );
```

#### 2.3.1.4 10 MHz PLL

Some boards can generate a timebase from an on-board PLL clocked by user supplied external 10 MHz reference signal input to its ECLK connector.

##### *2.3.1.4.1 ATS660*

In 10 MHz PLL external clock mode, the ATS660 can generate a sample clock between 110 and 130 MHz, in 1 MHz, steps from an external 10 MHz reference input.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source identifier, the desired sample rate between 110 and 130 MHz in 1 MHz steps, and a decimation factor of 1 to 100000. Note that the decimation value should be one less than the desired decimation factor.

The following code fragment shows how to generate a 32.5 MS/s sample rate (130 MHz / 3) from a 10 MHz PLL external clock input.

```
AlazarSetCaptureClock(
    handle,                     // HANDLE -- board handle
    EXTERNAL_CLOCK_10MHz_REF,   // U32 -- clock source Id
    130000000,                  // U32 -- sample rate Id or value
    CLOCK_EDGE_RISING,          // U32 -- clock edge Id
    2                           // U32 -- decimation value
    );
```

##### *2.3.1.4.2 ATS9325*

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In 10 MHz PLL external clock mode, the ATS9325 generates a 500 MHz sample clock from an external 10 MHz reference input. The 500 MS/s sample data can be decimated by a factor of 2, 4, or any multiple of 5.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source and 500 MHz as the sample rate, and select a decimation factor of 2, 4, or any multiple of 5 up to 100000.

For example, the following code fragment shows how to generate a 100 MS/s sample rate (500 MHz / 5) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF,  // U32 -- clock source Id
   500000000,                 // U32 -- sample rate Id
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   5                          // U32 -- decimation
   );
```

#### *2.3.1.4.3 ATS9350 /ATS9351*

In 10 MHz PLL external clock mode, the ATS9350 and ATS9351 generate a 500 MHz sample clock from an external 10 MHz reference input. The 500 MS/s sample data can be decimated by a factor of 1, 2, 4, or any multiple of 5.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source and 500 MHz as the sample rate, and select a decimation factor of 1, 2, 4, or any multiple of 5 up to 100000.

For example, the following code fragment shows how to generate a 100 MS/s sample rate (500 MHz / 5) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF,  // U32 -- clock source Id
   500000000,                 // U32 -- sample rate Id
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   5                          // U32 -- decimation
   );
```

#### *2.3.1.4.4 ATS9350 /ATS9351 Advanced 10 MHz PLL*

The ATS9350/ATS9351 can be ordered with an "Advanced 10 MHz PLL" option. This feature allows the digitizers to generate the following sample clock frequencies from a 10 MHz reference. Sample data can be decimated in hardware by a factor of 1, 2, 4, or any multiple of 5.

**Table 1 ATS9350 Advanced 10 MHz PLL supported ADC frequencies**

| Frequency range (1 MHz increments) | Supported sample rates |
|---|---|
| 10-19 MHz | All |

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| | |
|---|---|
| 20-29 MHz | All |
| 30-39 MHz | All |
| 40-49 MHz | All |
| 50-59 MHz | 50, 51, 52, 53, 54, 55, 56 and 58 MHz |
| 60-69 MHz | All |
| 70-79 MHz | 70, 71, 72, 73, 74, 75, 76 and 78 MHz |
| 80-89 MHz | 80, 82, 84, 85, 86 and 88 MHz |
| 90-99 MHz | All |
| 100-109 MHz | All |
| 110-119 MHz | 100 and 115 MHz |
| 120-129 MHz | 120, 122, 124, 125, 126 and 128 MHz |
| 130-139 MHz | 130, 132, 134, 135, 136 and 138 MHz |
| 140-149 MHz | 140, 142, 144, 145 and 146 MHz |
| 150-159 MHz | 150 and 155 MHz |
| 160-169 MHz | 160 and 165 MHz |
| 170-179 MHz | 170 and 175 MHz |
| 180-189 MHz | All |
| 190-199 MHz | All |
| 200-209 MHz | All |
| 210-219 MHz | All |
| 220-229 MHz | 220 and 225 MHz |
| 230-239 MHz | 230 and 235 MHz |
| 240-249 MHz | 240 and 245 MHz |
| 250-259 MHz | 250 and 255 MHz |
| 260-269 MHz | 260 and 265 MHz |
| 270-279 MHz | 270 and 275 MHz |
| 280-289 MHz | None |
| 290-299 MHz | None |
| 300-309 MHz | 300 and 305 MHz |
| 310-319 MHz | 310 and 315 MHz |
| 320-329 MHz | 320 and 325 MHz |
| 330-339 MHz | 330 and 335 MHz |
| 340-349 MHz | 340 and 345 MHz |
| 350-359 MHz | 350 and 355 MHz |
| 360-369 MHz | 360, 362, 364, 365, 366, 368 MHz |
| 370-379 MHz | 370, 372, 374, 376, 378 MHz |
| 380-389 MHz | 380, 382, 384, 386, 386 MHz |
| 390-399 MHz | 390, 392, 394, 396, 398 MHz |
| 400-409 MHz | 400, 402, 404, 406, 408 MHz |
| 410-419 MHz | 410, 412, 414, 416, 418 MHz |
| 420-429 MHz | 420, 422, 424, 426, 428 MHz |
| 430-439 MHz | 430, 432, 434, 436, 438 MHz |
| 440-449 MHz | 440 MHz |
| 450-459 MHz | 450 and 455 MHz |
| 460-469 MHz | 460 and 465 MHz |

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| | |
|---|---|
| 470-479 MHz | 470 and 475 MHz |
| 480-489 MHz | 480 and 485 MHz |
| 490-499 MHz | 490 and 495 MHz |
| 500 MHz | 500 MHz |

To use the Advanced 10 MHz PLL option, call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source, one of the values from the table above as the sample rate, and a decimation ratio of 1, 2, 4, or any multiple of 5 up to 100000.

For example, the following code fragment shows how to generate a 48.5 MS/s sample rate (485 MHz / 10) from a 10 MHz reference.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF, // U32 -- clock source Id
   485000000,                 // U32 -- sample rate Id
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   10                          // U32 -- decimation
   );
```

#### *2.3.1.4.5 ATS9360*

In 10 MHz PLL external clock mode, the ATS9360 can generate any sample clock frequency between 300 MHz and 1800 MHz that is a multiple of 1 MHz.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source identifier, the desired sample rate between 300 MS/s and 1800 MS/s, and 1 as the decimation ratio. The sample rate must be a multiple of 1 MHz.

For example, the following code fragment shows how to generate a 1.382 GS/s sample clock from a 10 MHz reference.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF, // U32 -- clock source Id
   1382000000,                // U32 -- sample rate
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   1                          // U32 -- decimation
   );
```

#### *2.3.1.4.6 ATS9440*

In 10 MHz PLL external clock mode, the ATS9440 can generate either a 125 MHz or 100 MHz sample clock from an external 10 MHz reference input. The 125 MS/s or 100 MS/s sample data can be decimated by a factor of 2, 4, or any multiple of 5.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source either 125 MHz or 100 MHz as the sample rate, and select a decimation radio between 1 and 100000.

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For example, the following code fragment shows how to generate a 25 MS/s sample rate (125 MHz / 5) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF, // U32 -- clock source Id
   125000000,                 // U32 -- sample rate Id
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   5                          // U32 -- decimation
   );
```

#### *2.3.1.4.7 ATS9462*

In 10 MHz PLL external clock mode, the ATS9462 can generate a sample clock between 150 and 180 MHz in 1 MHz steps from an external 10 MHz reference input. Sample data can be decimated by a factor of 1 to 100000.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source, the desired sample rate between 150 and 180 MHz in 1 MHz steps, and the decimation factor of 1 to 100000. Note that the decimation value should be one less than the desired decimation factor.

For example, the following code fragment shows how to generate a 15 MS/s sample rate (150 MHz / 10) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF, // U32 -- clock source Id
   150000000,                 // U32 -- sample rate Id or value
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
   9                          // U32 -- decimation value
   );
```

#### *2.3.1.4.8 ATS9625/ATS9626*

In 10 MHz PLL external clock mode, the ATS9625/ATS9626 can generate a 250 MHz sample clock from an external 10 MHz reference input. Sample data can be decimated by a factor of 1 to 100000.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source, 250 MHz has the sample rate value, and a decimation ratio of 1 to 100000.

For example, the following code fragment shows how to generate a 25 MS/s sample rate (250 MHz / 10) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
   handle,                    // HANDLE -- board handle
   EXTERNAL_CLOCK_10MHz_REF, // U32 -- clock source Id
   250000000,                 // U32 -- sample rate Id or value
   CLOCK_EDGE_RISING,         // U32 -- clock edge Id
```

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```
    10                          // U32 -- decimation value
    );
```

#### *2.3.1.4.9 ATS9850*

In 10 MHz PLL external clock mode, the ATS9850 generates a 500 MHz sample clock from an external 10 MHz reference input. The 500 MS/s sample data can be decimated by a factor of 1, 2, 4, or any multiple of 10.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source and 500 MHz as the sample rate value, and a decimation of 1, 2, 4, or any multiple of 10 up to 100000.

For example, the following code fragment shows how to generate a 125 MS/s sample rate (500 MHz / 4) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
    handle,                     // HANDLE -- board handle
    EXTERNAL_CLOCK_10MHz_REF,   // U32 -- clock source Id
    500000000,                  // U32 -- sample rate Id or value
    CLOCK_EDGE_RISING,          // U32 -- clock edge Id
    4                           // U32 -- decimation value
    );
```

#### *2.3.1.4.10 ATS9870*

In 10 MHz PLL external clock mode, the ATS9870 generates a 1 GHz sample clock from an external 10 MHz reference input. The 1 GS/s sample data can be decimated by a factor of 1, 2, 4, or any multiple of 10.

Call AlazarSetCaptureClock specifying EXTERNAL_CLOCK_10MHz_REF as the clock source and 1 GHz as the sample rate value, and a decimation of 1, 2, 4, or any multiple of 10 up to 100000.

For example, the following code fragment shows how to generate a 250 MS/s sample rate (1 GHz / 4) from a 10 MHz external clock input.

```
AlazarSetCaptureClock(
    handle,                     // HANDLE -- board handle
    EXTERNAL_CLOCK_10MHz_REF,   // U32 -- clock source Id
    1000000000,                 // U32 -- sample rate Id or value
    CLOCK_EDGE_RISING,          // U32 -- clock edge Id
    4                           // U32 -- decimation value
    );
```

### 2.3.1.5 Dummy clock

Scanning applications should consider using the "dummy clock" option if they generate an unusable external clock signal during horizontal retrace periods at the end of each scan line.

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When the "dummy clock" option enabled, the digitizer uses an internally generated clock signal to drive its ADCs for a specified amount of time after the end of each record. At the end of the dummy clock on time, the digitizer switches back to using the external clock signal to clock the ADCs.

Call AlazarSetClockSwitchOver to enable dummy clock mode, and set the amount of tiem to use the dummy clock after the end of each record.

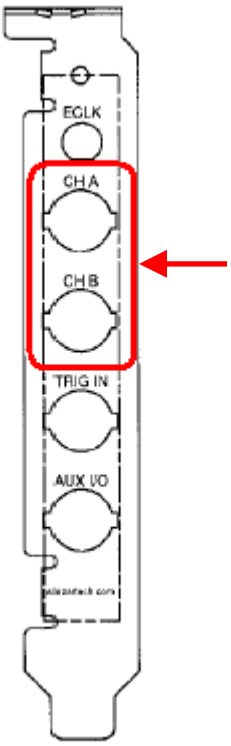
```
AlzarSetClockSwithOver(
   handle,                    // HANDLE -- board handle
   CSO_ENABLE_DUMMY_CLOCK,    // U32 -- mode
   dummyClockOnTime_ns,       // U32 -- dummy clock on time in ns
   0                          // U32 -- reserved
   );
```

Note that the on-time should be selected so that it is longer than the amount time that external clock signal is unstable, but not longer than the time between the end of one scanline and start of the next scan-line.

### 2.3.2 Input control

AlazarTech digitizers have analog amplifier sections that process the signals input to its analog input connectors before they are sampled by its ADC converters. The gain, coupling, and termination of the amplifier sections should be configured to match the properties of the input signals.

**Figure 2-3 CHA and CHB connectors on a PCI/PCIe mounting bracket.**



#### 2.3.2.1 Input range, coupling, and impedance

Call AlazarInputControl to specify the desired input range, termination, and coupling of an input channel.

The following code fragment configures input CH A for a range of ± 800 mV, DC coupling, and 50Ω termination.

```
AlazarInputControl(
    boardHandle,            // HANDLE -- board handle
    CHANNEL_A,              // U8 -- input channel
    DC_COUPLING,            // U32 -- input coupling id
    INPUT_RANGE_PM_800_MV,  // U32 -- input range id
    IMPEDANCE_50_OHM        // U32 -- input impedance id
    );
```

See AlazarInputControl and the board reference manual for a list of input range, coupling, and impedance identifiers appropriate for the board.

#### 2.3.2.2 Bandwidth filter

Some digitizers have a low pass filters that attenuate signals above about 20 MHz. By default, these filters are disabled. Call AlazarSetBWLimit to enable or disable the bandwidth limit filter.

The following code fragment enables the CH A bandwidth limit filter.

```
AlazarSetBWLimit (
  boardHandle,            // HANDLE -- board handle
  CHANNEL_A,              // U32 -- channel identifier
  1                       // U32 -- 0 = disable, 1 = enable
  );
```

#### 2.3.2.3 Amplifier bypass

Some digitizer models support "amplifier bypass" mode. In this mode, the analog signal supplied to an input connector is connected directly the ADC driver of that channel, bypassing its amplifier section.

Amplifier bypass mode must be enabled in hardware either through DIP switches on the board, or as a factory option. Once enabled in hardware, the following code fragment shows how to configure this option in software.

```
AlazarInputControl(
    handle,                 // HANDLE -- board handle
    CHANNEL_A,              // U8 -- input channel
    DC_COUPLING,            // U32 -- not used
    INPUT_RANGE_HI_FI,      // U32 -- input range id
    IMPEDANCE_50_OHM        // U32 -- not used
    );
```

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Note that when amplifier bypass mode option is enabled for an input channel, the channel's full-scale input range is fixed. The following table lists the nominal full-scale input range values that may be used to convert sample code values to volts.

| Model | Full scale input range |
|---|---|
| ATS460 | ± 525 mV |
| ATS660 | ± 550 mV |
| ATS9325/ATS9350 | ± 200 mV |
| ATS9351 | ± 400 mV |
| ATS9462 | ± 550 mV |
| ATS9850/ATS9870 | ± 256 mV |

See your board's hardware reference manual for more information about using amplifier bypass.

### 2.3.3 Trigger control

AlazarTech digitizer boards have a flexible triggering system with two separate trigger engines that can be used independently, or combined together to generate trigger events.

#### 2.3.3.1 AlazarSetTriggerOperation

Use the AlazarSetTriggerOperation API function to configure each of the two trigger engines, and to specify how they should be used to generate trigger events.

```
RETURN_CODE
AlazarSetTriggerOperation (
   HANDLE handle,
   U32 TriggerOperation,
   U32 TriggerEngineId1,
   U32 SourceId1,
   U32 SlopeId1,
   U32 Level1,
   U32 TriggerEngineId2,
   U32 SourceId2,
   U32 SlopeId2,
   U32 Level2
   );
```

The following paragraphs describe each of the function's parameters, and provide examples showing how to use the function.

##### *2.3.3.1.1 Trigger engine*

The trigger engine identifier parameter specifies which of the two trigger engines you wish to configure. The parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIG_ENGINE_J | 0 | Configure trigger engine J |
| TRIG_ENGINE_K | 1 | Configure trigger engine K |

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#### *2.3.3.1.2 Data source*

The data source identifier parameter selects the where the specified trigger engine should get its data. The parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIG_CHAN_A | 0 | Use samples from CH A |
| TRIG_CHAN_B | 1 | Use samples from CH B |
| TRIG_EXTERNAL | 2 | Use a signal from TRIG IN |
| TRIG_DISABLE | 3 | Disable this trigger engine. |
| TRIG_CHAN_C | 4 | Use samples from CH C |
| TRIG_CHAN_D | 5 | Use samples from CH D |

#### *2.3.3.1.3 Trigger slope*

The trigger slope identifier parameter selects if the output of the specified trigger engine should become active when sample values from the specified trigger source rise above, or fall below, a specified level. The parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIGGER_SLOPE_POSITIVE | 1 | The trigger engine output goes from low to high when sample values from the trigger source rise above a specified level. |
| TRIGGER_SLOPE_NEGATIVE | 2 | The trigger engine output goes from low to high when sample values from the trigger source fall below a specified level. |

#### *2.3.3.1.4 Trigger level*

The trigger level parameter sets the level that the trigger source must rise above, or fall below, for the selected trigger engine to become active. The trigger level is specified as an unsigned 8-bit code that represents a fraction of the full scale input range of the trigger source; 0 represents the negative full-scale input, 128 represents a 0 volt input, and 255 represents the positive full-scale input.

For example, if the trigger source is CH A, and the CH A input range is ± 800 mV, then 0 represents a –800 mV trigger level, 128 represents a 0 V trigger level, and 255 represents +800 mV trigger level.

In general, the trigger level value is given by:

```
TriggerLevelCode = 128 + 127 * TriggerLevelVolts / InputRangeVolts.
```

The following table gives examples of how trigger level codes map to trigger levels in volts according to the full-scale input range of the trigger source.

| Trigger | Trigger level as | Trigger level if | Trigger level if |
|---|---|---|---|

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| level code | fraction of source input range | source has ±1 V input range | source has ±5 V input range |
|---|---|---|---|
| 0 | -100% | -1V | -5V |
| 64 | -50% | -500 mV | -2.5 V |
| 96 | -25% | -250 mV | -1.25 V |
| 128 | 0% | 0 V | 0 V |
| 160 | +25 % | 250 mV | 1.25 V |
| 192 | +50% | +500 mV | +2.5 V |
| 255 | +100% | +1V | +5V |

#### *2.3.3.1.5 Trigger operation*

Finally, the trigger operation identifier specifies how the outputs of from the two trigger engines are combined to generate trigger events. This parameter may have one of the following values where the symbol $T_j$ represents the output of trigger engine J, and $T_k$ represents the output of trigger engine K.

| Identifier | Value | Meaning<br>Generate a trigger event when… |
|---|---|---|
| TRIG_ENGINE_OP_J | 0 | $T_j$ goes low to high. |
| TRIG_ENGINE_OP_K | 1 | $T_k$ goes low to high. |
| TRIG_ENGINE_OP_J_OR_K | 2 | $T_j$ goes low to high, or $T_k$ goes low to high. |
| TRIG_ENGINE_OP_J_AND_K | 3 | ($T_j$ AND $T_{k)}$ goes low to high. |
| TRIG_ENGINE_OP_J_XOR_K | 4 | ($T_j$ XOR $T_{k)}$ goes low to high. |
| TRIG_ENGINE_OP_J_AND_NOT_K | 5 | ($T_j$ AND (NOT $T_k$)) goes low to high. |
| TRIG_ENGINE_OP_NOT_J_AND_K | 6 | ((NOT $T_j$)AND $T_k$) goes low to high. |

### 2.3.3.2 AlazarSetTriggerOperation examples

The following code fragment configures a board to trigger when the signal connected to CH A rises above 0V. This example only uses trigger engine J.

```
AlazarSetTriggerOperation(
   handle,                 // HANDLE -- board handle
   TRIG_ENGINE_OP_J,       // U32 -- trigger operation
   TRIG_ENGINE_J,          // U32 -- trigger engine id
   TRIG_CHAN_A,            // U32 -- trigger source id
   TRIGGER_SLOPE_POSITIVE, // U32 -- trigger slope id
   128,                    // U32 -- trigger level (128 = 0V)
   TRIG_ENGINE_K,          // U32 -- trigger engine id
   TRIG_DISABLE,           // U32 -- trigger source id for engine K
   TRIGGER_SLOPE_POSITIVE, // U32 -- trigger slope id
   128                     // U32 -- trigger level (0 - 255)
);
```

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The following code fragment configures a board to trigger when the signal connected to CH B rises above 500 mV, or falls below -200 mV, if CH B's input range is ±1V. This example uses both trigger engine J and K.

```
double inputRange_volts = 1.; // ±1V range

double TriggerLevelJ_volts = .5;  // +500 mV trigger level
U32 triggerLevelJ =               // U32 -- trigger level J (192)
   (U32)(128 + 127 * triggerLevelJ_volts / inputRange_volts);

double triggerLevelK_volts = -.2; // -200 mV trigger level
U32 triggerLevelK =               // U32 – trigger level K (103)
   (U32)(128 + 127 * triggerLevelK_volts / inputRange_volts);

AlazarSetTriggerOperation(
   handle,                  // HANDLE -- board handle
   TRIG_ENGINE_OP_J_OR_K,   // U32 -- trigger operation
   TRIG_ENGINE_J,           // U32 -- trigger engine id
   TRIG_CHAN_B,             // U32 -- trigger source id
   TRIGGER_SLOPE_POSITIVE, // U32 -- trigger slope id
   triggerLevelJ,           // U32 -- trigger level from 0 to 255
   TRIG_ENGINE_K,           // U32 -- trigger engine id
   TRIG_DISABLE,            // U32 -- trigger source id for engine K
   TRIGGER_SLOPE_POSITIVE, // U32 -- trigger slope id
   triggerLevelK,           // U32 -- trigger level from 0 to 255
);
```

#### 2.3.3.3 External trigger

AlazarTech digitizer boards can trigger on a signal connected to its TRIG IN connector.

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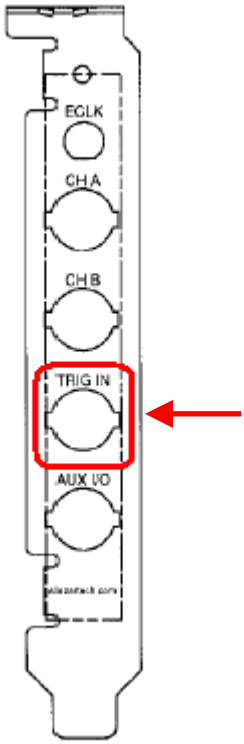
**Figure 2-4 External trigger connector on PCI/PCIe mounting bracket.**




To use an external trigger input:

- Call AlazarSetTriggerOperation with TRIG_EXTERNAL as the trigger source identifier of at least one of the trigger engines; and
- Call AlazarSetExternalTrigger to select the range and coupling of the external trigger input.

The following code fragment configures a board to trigger when the signal connected to the TRIG IN falls below +2 V, assuming the signal's range is less than ± 5V with DC coupling.

```
// Calculate the trigger level code from the level and range

double triggerLevel_volts = 2.; // trigger level
double triggerRange_volts = 5.; // input range
U32 triggerLevel_code =
   (U32)(128 + 127 * triggerLevel_volts / triggerRange_volts);

// Configure trigger engine J to generate a trigger event
// on the falling edge of an external trigger signal.

AlazarSetTriggerOperation(
   handle,                 // HANDLE -- board handle
   TRIG_ENGINE_OP_J,       // U32 -- trigger operation
   TRIG_ENGINE_J,          // U32 -- trigger engine id
   TRIG_EXTERNAL,          // U32 -- trigger source id
   TRIGGER_SLOPE_NEGATIVE, // U32 -- trigger slope id
```

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```
    triggerLevel,           // U32 -- trigger level (0 - 255)
    TRIG_ENGINE_K,          // U32 -- trigger engine id
    TRIG_DISABLE,           // U32 -- trigger source id for engine K
    TRIGGER_SLOPE_POSITIVE, // U32 -- trigger slope id
    128                     // U32 -- trigger level (0 - 255)
);

// Configure the external trigger input to +/-5V range,
// with DC coupling

AlazarSetExternalTrigger(
    handle,                  // HANDLE -- board handle
    DC_COUPLING,             // U32 -- coupling id
    ETR_5V                   // U32 -- external range id
);
```

#### 2.3.3.4 Trigger timeout

AlazarTech digitizer boards can be configured to automatically trigger when the board is waiting for a trigger event, but no trigger events arrive after a specified time interval. This behavior is similar to the "automatic" trigger mode of oscilloscopes, and may be useful to capture waveforms when trigger conditions are unknown.

Call AlazarSetTriggerTimeOut to specify the amount of time that a board should wait for a hardware trigger event before automatically generating a software trigger event and, as a result, acquiring one record. The timeout value is expressed in 10 µs units, where 0 means disable the timeout counter and wait forever for a trigger event.

The trigger timeout value should be set to zero once stable trigger parameters have been found. Otherwise, a board may generate unexpected trigger events if the trigger timeout interval expires before a hardware trigger event occurs.

The following code fragment configures a board to automatically trigger and acquire one record if it does not receive a trigger event after 1 ms.

```
double timeout_sec = 1.e-3;    // 1 ms
U32 timeout_ticks = (U32)(timeout_sec / 10.e-6 + 0.5);

AlazarSetTriggerTimeOut(
    boardHandle,      // HANDLE -- board handle
    timeout_ticks     // U32 - timeout_sec / 10.e-6 (0 = infinite)
    );
```

The following code fragment configures a board to wait forever for trigger events.

```
AlazarSetTriggerTimeOut(
    boardHandle,  // HANDLE -- board handle
    0             // U32 -- timeout_sec / 10.e-6 (0 = infinite)
    );
```

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#### 2.3.3.5 Trigger delay

An AlazarTech digitizer board can be configured to wait for a specified amount of time after it receives a trigger event before capturing a record for the trigger.

Call AlazarSetTriggerDelay to specify a time, in sample clock periods, to wait after receiving a trigger event for a record before capturing samples for that record.

The following code fragment shows how to set a trigger delay of 1 ms, given a sample rate of 100 MS/s.

```
double triggerDelay_sec = 1.e-3;    // 1 ms
double samplesPerSec = 100.e6;      // 100 MS/s
U32 triggerDelay_samples =
   (U32)(triggerDelay_sec * samplesPerSec + 0.5);

AlazarSetTriggerDelay(
   boardHandle,              // HANDLE -- board handle
   triggerDelay_samples      // U32 -- trigger delay in samples
   );
```

#### 2.3.3.6 AlazarSetTriggerOperationForScanning

AlazarTech digitizers require that the ADC clock be valid when an application calls AlazarStartCapture to arm a board to begin an acquisition. The digitizer may not be able to start an acquisition if the the application calls AlazarStartCapture while the ADC clock is invalid

If an application uses both external clock and external trigger signals, and the external clock is not suitable to drive the ADC's during part of the interval between trigger events, the application can call AlazarSetTriggerOperationForScanning (rather than AlazarSetTriggerOperation) to configure the trigger engines. This function configures the trigger engines to use an external trigger source connected to the TRIG IN connector, and also allows the board to begin an acquisition on the next external trigger event after the call to AlazarStartCapture, when the external clock signal is valid.

For example, some OCT applications use a laser source that supplies an external clock signal that is valid on the rising edge of the trigger pulse, but falls to 0 Hz on the falling edge of the trigger pulse. The digitizer may not work correctly if the application calls AlazarStartCapture to arm the board while the clock output is at 0 Hz. These applications can call AlazarSetTriggerOperationForScanning to configure the trigger engines to use an external trigger input, and to wait until the first rising edge of the external trigger pulse arrives after the call the AlazarStartCapture to start the acquisition, when the external clock is valid.

```
RETURN_CODE
AlazarSetTriggerOperationForScanning (
   HANDLE handle,
   U32 SlopeId,            // trigger slope identifier
   U32 Level,              // trigger level code
```

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```
    U32 Options             // scanning options
    );
```

AlazarSetTriggerOperationForScanning configures a board to use trigger operation TRIG_ENGINE_OP_J, and configures the source of TRIG_ENGINE_J to be TRIG_EXTERNAL. The application must call AlazarSetExternalTrigger to set the full-scale external input range and coupling of the external trigger signal connected to the TRIG IN connector.

The slope identifier parameter selects if a trigger event should be generated when the external trigger level rise above, or falls below, a specified level. The parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIGGER_SLOPE_POSITIVE | 1 | The external trigger level rises above a specified level. |
| TRIGGER_SLOPE_NEGATIVE | 2 | The external trigger level falls below a specified level. |

The trigger level parameter sets the external trigger level as an unsigned 8-bit code that represents a fraction of the external trigger full scale input range: 0 represents the negative full-scale input, 128 represents a 0 volt input, and 255 represents the positive full-scale input.

In general, the trigger level value is given by:

```
TriggerLevelCode = 128 + 127 * TriggerLevelVolts / InputRangeVolts
```

The following table gives examples of how trigger level codes map to trigger levels in volts according to the external trigger full-scale input range.

| Trigger level code | Trigger level as fraction of external input range | Trigger level in ±1V external trigger range | Trigger level in ±5V external trigger input range |
|---|---|---|---|
| 0 | -100% | -1V | -5V |
| 64 | -50% | -500 mV | -2.5 V |
| 96 | -25% | -250 mV | -1.25 V |
| 128 | 0% | 0 V | 0 V |
| 160 | +25 % | 250 mV | 1.25 V |
| 192 | +50% | +500 mV | +2.5 V |
| 255 | +100% | +1V | +5V |

The options parameter may be one of the following flags:

| Identifier | Meaning |
|---|---|
| STOS_OPTION_DEFER_START_CAPTURE (0x00000001) | Wait until the next external trigger event after the |

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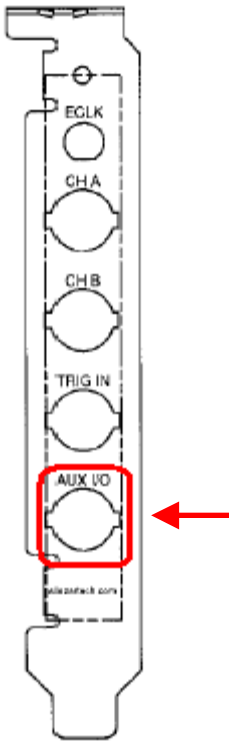
| | |
|---|---|
| | application calls AlazarStartCapture before arming the board to start the acquisition. The external clock input should be valid when the trigger event arrives. |

### 2.3.4 AUX I/O

AlazarTech digitizer boards with an AUX I/O connector can be configured to supply a 5V TTL-level output signal, or to receive a TTL-level input signal on this connector.

**Figure 2-5 Auxiliary I/O connector on PCI/PCIe mounting bracket**




Use AlazarConfigureAuxIO to configure the function of the AUX I/O connector.

The ATS9440 has two AUX I/O connectors: AUX I/O 1 and AUX I/O 2. AUX I/O 1 is configured by firmware as a trigger output signal, while AUX I/O 2 is configured by software using AlazarConfigureAuxIO. A custom FPGA is required to change the operation of AUX I/O 1.

The ATS9625 and ATS9626 have two AUX I/O connectors: AUX1 and AUX2. AUX1 is configured by by software using AlazarConfigureAuxIO, while AUX2 is configured by the main FPGA as a trigger output signal by default. AUX2 can be controlled by its user-programmable FPGA as desired by the FPGA designer.

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#### 2.3.4.1 Trigger output

The AUX I/O connector can be configured to supply a trigger output signal, where the edge of the trigger output signal is synchronized with the edge of the sample clock. Note that this is the default power-on mode for the AUX I/O connector.

The following code fragment configures the AUX I/O connector as a trigger output signal.

```
AlazarConfigureAuxIO(
    handle,                 // HANDLE -- board handle
    AUX_OUT_TRIGGER,        // U32 -- mode
    0                       // U32 -- parameter
    );
```

#### 2.3.4.2 Pacer output

The AUX I/O connector can be configured to output the sample clock divided by a programmable value. This option may be used to generate a clock signal synchronized with the sample clock of the digitizer board.

The following code fragment generates a 10 MHz signal on an AUX I/O connector, given a sample rate of 180 MS/s.

```
AlazarConfigureAuxIO(
    handle,                 // HANDLE -- board handle
    AUX_OUT_PACER,          // U32 -- mode
    18                      // U32 -- sample clock divider
    );
```

Note that the sample rate divider value must be greater than 2, and that the signal output may be limited by the bandwidth of the output's TTL drivers.

#### 2.3.4.3 Digital output

The AUX I/O connector can be configured to output a TTL high or low signal. This mode allows a programmer to use the AUX I/O connector as a general purpose digital output.

The following code fragment configures the AUX I/O connector as a digital output.

```
AlazarConfigureAuxIO(
    handle,                 // HANDLE -- board handle
    AUX_OUT_SERIAL_DATA,    // U32 -- mode
    0                       // U32 -- 0 = low, 1 = high
    );
```

#### 2.3.4.4 Trigger enable input

The AUX I/O connector can be configured as an AutoDMA trigger enable input signal. When enabled, a board will:

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- Wait for a rising or falling edge on the AUX I/O.
- Wait for the number of trigger events necessary to capture the number of "records per buffer" in one AutoDMA segment specified at the start of the acquisition.
- Repeat.

The following code fragment configures the AUX I/O connector to acquire "records per buffer" records after it receives the rising edge of a TTL pulse connected on the AUX I/O connector.

```
AlazarConfigureAuxIO(
    handle,                 // HANDLE -- board handle
    AUX_IN_TRIGGER_ENABLE,  // U32 -- mode
    TRIGGER_SLOPE_POSITIVE  // U32 -- parameter
    );
```

See section 2.4.2.8 "AutoDMA Scanning Applications" for more information.

#### 2.3.4.5 Digital input

The AUX I/O connector can be configured to read the TTL level of a signal input to the AUX connector. This mode allows a programmer to use the AUX I/O connector as a general purpose digital input.

The following code fragment configures the AUX I/O connector as a digital input.

```
AlazarConfigureAuxIO(
    handle,                 // HANDLE -- board handle
    AUX_IN_AUXILIARY,       // U32 -- mode
    0                       // U32 -- not used
    );
```

Once configured as a serial input, the following code fragment reads the AUX input level.

```
long level;
AlazarGetParameter(
    handle,                 // HANDLE -- board handle
    0,                      // U8 -- channel
    GET_AUX_INPUT_LEVEL,    // U32 -- parameter
    &level                  // long* -- 0 = low, 1 = high
    );
```

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## 2.4 Acquiring data

AlazarTech digitizers may be configured to acquire in one of the following modes:

- "Single port" mode acquires data to on-board memory and then, after the acquisition is complete, transfers data from on-board memory to application buffers.
- "Dual port AutoDMA" mode acquires to on-board memory while, at the same time, transferring data from on-board memory to application buffers.

### 2.4.1 Single port

The single-port acquisition API allows an application to capture records to on-board memory – one per trigger event – and transfer records from on-board to host memory. Data acquisition and data transfer are made serially, so trigger events may be missed if they occur during data transfers.

The single port acquisition API may be used if:

- A board has single-port or dual-port on-board memory.
- An application can miss trigger events that occur while it is transferring data from on-board to host memory.

The singe port acquisition API must be used if:

- A board does not have dual-port or FIFO on-board memory.
- An application acquires data at an average rate that is greater than maximum transfer rate of the board's PCI or PCIe host bus interface.

Ultrasonic testing, OCT, radar, imaging and similar applications should not use the single-port acquisition API; rather, they should use the dual-port acquisition API described in section 2.4.2 below.

#### 2.4.1.1 Acquiring to on-board memory

##### *2.4.1.1.1 Dual channel mode*

By default, AlazarTech digitizer boards share on-board memory equally between both of a board's input channels. A single-port acquisition in dual-channel mode captures samples from both input channels simultaneously to on-board memory and, after the acquisition is complete, allows samples from either input channel to be transferred from on-board memory to an application buffer.

To program a board acquire to on-board memory in dual-channel mode:

1. Call AlazarSetRecordSize to set the number of samples per record, where a record may contain samples before and after its trigger event.
2. Call AlazarSetRecordCount to set the number records per acquisition – the board captures one record per trigger event.
3. Call AlazarStartCapture to arm the board to wait for trigger events.

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4. Call AlazarBusy in a loop to poll until the board has received all trigger events in the acquisition, and has captured all records to on-board memory.
5. Call AlazarRead, AlazarReadEx, or AlazarHyperDisp to transfer records from on-board memory to host memory.
6. Repeat from step 3, if necessary.

The following code fragment acquires to on board memory with on-board memory shared between both input channels.

```
// 1. Set record size

AlazarSetRecordSize (
    boardHandle,            // HANDLE -- board handle
    preTriggerSamples,      // U32 -- pre-trigger samples
    postTriggerSamples      // U32 -- post-trigger samples
    );

// 2. Set record count

AlazarSetRecordCount(
    boardHandle,            // HANDLE -- board handle
    recordsPerCapture       // U32 -- records per acquisition
    );

// 3. Arm the board to wait for trigger events

AlazarStartCapture(boardHandle);

// 4. Wait for the board to receive all trigger events
// and capture all records to on-board memory

while (AlazarBusy (boardHandle))
{
    // The acquisition is in progress
}

// 5. The acquisition is complete. Call AlazarRead or
// AlazarHyperDisp to transfer records from on-board memory
// to your buffer.
```

#### *2.4.1.1.2 Single channel mode*

ATS9325, ATS9350, ATS9351, ATS9440, ATS9625, ATS9626, ATS9850, and ATS9870 and digitizer boards can be configured to dedicate all on-board memory to one of a board's input channels. A single-port acquisition in single-channel mode only captures samples from the specified channel to on-board memory and, after the acquisition is complete, only allows samples from the specified channel to be transferred from on-board memory to an application buffer.

To program a board acquire to on-board memory in single-channel mode:

1. Call AlazarSetRecordSize to set the number of samples per record, where a record may contain samples before and after its trigger event.

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2. Call AlazarSetRecordCount to set the number records per acquisition – the board captures one record per trigger event.
3. Call AlazarSetParameter with the parameter SET_SINGLE_CHANNEL_MODE, and specify the channel to use all memory.
4. Call AlazarStartCapture to arm the board to wait for trigger events.
5. Call AlazarBusy in a loop to poll until the board has received all trigger events in the acquisition, and has captured all records to on-board memory.
6. Call AlazarRead, AlazarReadEx, or AlazarHyperDisp to transfer records from on-board memory to host memory.
7. Repeat from step 3, if necessary.

The following code fragment acquires to on-board memory from CH A in single channel mode.

```
// 1. Set record size

AlazarSetRecordSize (
    boardHandle,            // HANDLE -- board handle
    preTriggerSamples,      // U32 -- pre-trigger samples
    postTriggerSamples      // U32 -- post-trigger samples
    );

// 2. Set record count

AlazarSetRecordCount(
    boardHandle,            // HANDLE -- board handle
    recordsPerCapture       // U32 -- records per acquisition
    );

// 3. Enable single channel mode

AlazarSetParameter(
    boardHandle,             // HANDLE -- board handle
    0,                       // U8 -- channel Id (not used)
    SET_SINGLE_CHANNEL_MODE, // U32 -- parameter
    CHANNEL_A                // long - CHANNEL_A or CHANNEL_B
    );

// 4. Arm the board to wait for trigger events

AlazarStartCapture(boardHandle);

// 5. Wait for the board to receive all trigger events
// and capture all records to on-board memory

while (AlazarBusy (boardHandle))
{
    // The acquisition is in progress
}

// 6. The acquisition is complete. Call AlazarRead or
// AlazarHyperDisp to transfer records from on-board memory
// to your buffer.
```

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Note that a call to AlazarSetParameter must be made before each call to AlazarStartCapture.

If the of number of samples per record specified in AlazarSetRecordSize is greater than the maximum number of samples per channel in dual-channel mode, but is less than the maximum number of samples per record in single-channel mode, and AlazarSetParameter is not called before calling AlazarStartCapture, then AlazarStartCapture will fail with error ApiNotSupportedInDualChannelMode (591).

#### 2.4.1.2 Using AlazarRead

Use AlazarRead to transfer samples from records acquired to on-board memory to a buffer in host memory.

##### *2.4.1.2.1 Transferring full records*

The following code fragment transfers a full CH A record from on-board memory to a buffer in host memory.

```
// Allocate a buffer to hold one record.
// Note that the buffer must be at least 16 samples
// larger than the number of samples per record.

U32 allocBytes = bytesPerSample * (samplesPerRecord + 16);
void* buffer = malloc(allocBytes);

// Transfer a CHA record into our buffer
AlazarRead (
    boardHandle,                // HANDLE -- board handle
    CHANNEL_A,                  // U32 -- channel Id
    buffer,                     // void* -- buffer
    bytesPerSample,             // int -- bytes per sample
    (long) record,              // long -- record (1 indexed)
    -((long)preTriggerSamples), // long -- trigger offset
    samplesPerRecord            // U32 -- samples to transfer
    );
```

See "%ATS_SDK_DIR%\Samples\SinglePort\AR" for a complete sample program that demonstrates how to use AlazarRead to read full records.

##### *2.4.1.2.2 Transferring partial records*

AlazarRead can transfer a segment of a record from on-board memory to a buffer in host memory. This may be useful if:

- The number of bytes in a full record in on-board memory exceeds the buffer size in bytes that an application can allocate in host memory.
- An application wishes to reduce the time required for data transfer when it acquires relatively long records to on-board memory, but is only interested in a relatively small part of the record.

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Use the "TransferOffset" parameter in the call to AlazarRead to specify the offset, in samples from the trigger position in the record, of the first sample to transfer from on-board memory to the application buffer. And use the "TransferLength" parameter to specify the number of samples to transfer from on-board memory to the application buffer, where this number of samples may be less than the number of samples per record.

The following code fragment divides a record into segments, and transfers the segments from on-board to host memory.

```
// Allocate a buffer to hold one record segment.
// Note that the buffer must be at least 16 samples
// larger than the number of samples per buffer.

U32 allocBytes = bytesPerSample * (samplesPerBuffer + 16);
void* buffer = malloc(allocBytes);

// Transfer a record in segments from on-board memory

U32 samplesToRead = samplesPerRecord;
long triggerOffset_samples = -(long)preTriggerSamples;

while (samplesToRead > 0)
{
    // Transfer a record segment from on-board memory

    U32 samplesThisRead;
    if (samplesToRead > samplesPerBuffer)
        samplesThisRead = samplesPerBuffer;
    else
        samplesThisRead = samplesToRead;

    AlazarRead (
        boardHandle,                // HANDLE -- board handle
        CHANNEL_A,                  // U32 -- channel Id
        buffer,                     // void* -- buffer
        bytesPerSample,             // int -- bytes per sample
        (long) record,              // long -- record (1 indexed)
        triggerOffset_samples,      // long -- trigger offset
        samplesThisRead             // U32 -- samples to transfer
        );

    // Process the record segment here
    WriteSamplesToFile(buffer, samplesThisRead);

    // Point to next record segment in on-board memory
    triggerOffset_samples += samplesThisRead;

    // Decrement number of samples left to read
    samplesToRead -= samplesThisRead;
}
```

See "%ATS_SDK_DIR%\Samples\SinglePort\AR_Segments" for a complete sample program that demonstrates how to read records in segments.

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#### 2.4.1.3 Using AlazarReadEx

AlazarRead can transfer samples from records acquired to on-board memory that contain up to 2,147,483,647 samples. If a record contains 2,147,483,648 or more samples, use AlazarReadEx rather than AlazarRead.

AlazarReadEx uses signed 64-bit transfer offsets, while AlazarRead uses signed 32-bit transfer offsets. Otherwise, AlazarReadEx and AlazarRead are identical.

#### 2.4.1.4 Using AlazarHyperDisp

HyperDisp technology enables the FPGA on an AlazarTech digitizer board to process sample data. The FPGA divides a record in on-board memory into intervals, finds the minimum and maximum sample values during each interval, and transfers an array of minimum and maximum value pairs to host memory. This allows the acquisition of relatively long records to on-board memory, but the transfer of relatively short processed records across the PCI/PCIe bus to host memory.

For example, an ATS860-256M would require over 2 seconds per channel to transfer 256,000,000 samples across the PCI bus. However, with HyperDisp enabled the ATS860 would require a fraction of a second to calculate HyperDisp data, and transfer a few kilobytes of processed data across the PCI bus. If an application was searching these records for glitches, it may save a considerable amount of time by searching HyperDisp data for the glitches and, if a glitch were found, transfer the raw sample data from the interval from on-board memory to host memory.

Use AlazarHyperDisp to enable a board to process records in on-board memory, and transfer processed records to host memory.

The following code fragment enables an ATS860-256M to process a record in on-board memory containing 250,000,000 samples into an array of 100 HyperDisp points, where each point contains the minimum and maximum sample values over an interval of 2,500,000 samples in the record.

```
// Specify number of samples per record

U32 preTriggerSamples = 125000000;
U32 postTriggerSamples = 125000000;
U32 samplesPerRecord = preTriggerSamples + postTriggerSamples;
U32 recordsPerCapture = 1;

// Acquire to on-board memory (omitted)

// Specify the number of HyperDisp points
U32 pointsPerRecord = 100;

// Allocate a buffer to store the HyperDisp data

U32 bytesPerSample = 1;          // ATS860 constant
U32 samplesPerPoint = 2;         // HyperDisp constant
U32 bytesPerBuffer =
```

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```
        bytesPerSample * samplesPerPoint * pointsPerRecord;
U8 *buffer = (U8*) malloc(bytesPerBuffer);

// Enable ATS860 FPGA to process the 250M sample record
// in on-board memory into an array of 100 HyperDisp points,
// and transfer the HyperDisp points into our buffer

U32 error;

AlazarHyperDisp (
    boardHandle,                // HANDLE -- board handle
    NULL,                       // void* -- reserved
    samplesPerRecord,           // U32 -- BufferSize
    (U8*) buffer,               // U8* -- ViewBuffer
    bytesPerBuffer,             // U32 -- ViewBufferSize
    pointsPerRecord,            // U32 -- NumOfPixels
    1,                          // U32 -- Option (1 = HyperDisp)
    CHANNEL_A,                  // U32 -- ChannelSelect
    1,                          // U32 -- record (1 indexed)
    -(long)preTriggerSamples,   // long -- TransferOffset
    &error                      // U32* -- error
    );
```

See "%ATS_SDK_DIR%\Samples\SinglePort\HD" for a complete sample program that demonstrates how to use AlazarHyperDisp.

#### 2.4.1.5 Record timestamps

AlazarTech digitizer boards include a 40-bit counter clocked by the sample clock source scaled by a board specific divider. When a board receives a trigger event to capture a record to on-board memory, it latches and saves the value of this counter. The counter value gives the time, relative to when the counter was reset, when the trigger event for the record occurred.

By default, this counter is reset to zero at the start of each acquisition. Use AlazarResetTimeStamp to control when the record timestamp counter is reset.

Use AlazarGetTriggerAddress to retrieve the timestamp, in timestamp clock ticks, of a record acquired to on-board memory. This function does not convert the timestamp value to seconds.

The following code fragment gets the record timestamp of a record acquired to on-board memory, and converts the timestamp value from clocks ticks to seconds.

```
// Read the record timestamp

U32 triggerAddress;
U32 timestampHigh;
U32 timestampLow;

AlazarGetTriggerAddress (
    boardHandle,            // HANDLE -- board handle
```

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```
        record,                 // U32 -- record number (1-indexed)
        &triggerAddress,        // U32* -- trigger address
        &timestampHigh,         // U32* -- timestamp high part
        &timestampLow           // U32* -- timestamp low part
        );

    // Convert the record timestamp from counts to seconds

    __int64 timeStamp_cnt;
    timeStamp_cnt = ((__int64) timestampHigh) << 8;
    timeStamp_cnt |= timestampLow & 0x0ff;

    double samplesPerTimestampCount = 2; // board specific constant
    double samplesPerSec = 50.e6;        // sample rate
    double timeStamp_sec = (double) samplesPerTimestampCount *
        timeStamp_cnt / samplesPerSec;
```

Call AlazarGetParameter with the GET_SAMPLES_PER_TIMESTAMP_CLOCK parameter to obtain the board specific "samples per timestamp count" value. The following table lists these values.

| Model | Samples per timestamp count |
|---|---|
| ATS310, ATS330,<br>ATS460, ATS660,<br>ATS9462,<br>ATS9850, ATS9870,<br>ATS9325, ATS9350, ATS9351, | 2 |
| ATS850, ATS860,<br>ATS9625, ATS8626 | 4 |
| ATS9440 | 1 |

See "%ATS_SDK_DIR%\Samples\SinglePort\AR_Timestamps" for a complete sample program that demonstrates how to retrieve record timestamps and convert them to seconds.

#### 2.4.1.6 Master-slave applications

If the single-port API is used to acquire from master-slave board system, only the master board in the board system should receive calls to the following API functions: AlazarStartCapture, AlazarAbortCapture, AlazarBusy, AlazarTriggered and AlazarForceTrigger.

See "%ATS_SDK_DIR%\Samples\SinglePort\AR_MasterSlave" for a sample program that demonstrates how to acquire from a master-slave system.

### 2.4.2 Dual port AutoDMA

AutoDMA allows a board to capture sample data to on-board dual-port memory while – at the same time – transferring sample data from on-board dual-port memory to a buffer

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in host memory. Data acquisition and data transfer are done in parallel, so any trigger events that occur while the board is transferring data will not be missed.

AutoDMA may be used if:

- A board has dual-port or FIFO on-board memory.
- An application acquires at an average rate, in MB/s, that is less than maximum transfer rate of your board's PCI or PCIe host bus interface.

AutoDMA must be used if:

- A board has FIFO on-board memory.
- An application cannot miss trigger events that occur while it transfers data to host memory, or re-arms for another acquisition.
- An application acquires more sample points or records than can be stored in on-board memory.

Applications such as ultrasonic testing, OCT, radar, and imaging should use AutoDMA.

An AutoDMA acquisition is divided into segments. AutoDMA hardware on a board transfers sample data, one segment at a time, from on-board memory to a buffer in host memory. There may be an unlimited number of segments in an AutoDMA acquisition, so a board can be armed to make an acquisition of infinite duration.

There are four AutoDMA operating modes.

| AutoDMA mode | Triggered | Pre-trigger samples | Record headers | Description |
|---|---|---|---|---|
| Traditional | Yes | Yes | Optional | Acquire multiple records – one per trigger event. Each record may contain samples before and after its trigger event. Each buffer contains one or more records. A record header may optionally precede each record. Supports low trigger repeat rates. |
| NPT (NoPreTrigger) | Yes | No | No | Acquire multiple records – one per trigger event. Each record may contain only samples after its trigger event. Each buffer contains one or more records. Support high trigger repeat rates. |
| Triggered streaming | Yes | No | No | Acquire a single, gapless record spanning multiple buffers, where each buffer contains a segment from the record. Wait for a trigger event before acquiring the record. |

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| | | | | |
|---|---|---|---|---|
| Continuous streaming | No | No | No | Acquire a single, gapless record spanning multiple buffers, where each buffer contains a segment from the record. Do not wait for a trigger event before acquiring the record. |

To make an AutoDMA acquisition, an application must:

- Specify the AutoDMA mode, samples per record, records per buffer, and records per acquisition.
- Arm the board to start the acquisition.
- Wait for an AutoDMA buffer to be filled, process the buffer, and repeat until the acquisition is complete.

The ATS-SDK supplies two groups of functions to make AutoDMA acquisitions: the Asynchronous AutoDMA and Synchronous AutoDMA APIs. Both allow a board to transfer a segment of an AutoDMA acquisition into one buffer while – at the same time – the application processes a previous segment of the acquisition in another buffer.

The following table compares the asynchronous and synchronous AutoDMA APIs.

| Attribute | Asynchronous AutoDMA | Synchronous AutoDMA |
|---|---|---|
| DMA buffer count | Application defined. | Two API allocated buffers. |
| CPU usage | Interrupt driven, so very low. More CPU cycles are available to application threads. | Polling loop, so very high. Less CPU cycles are available to application threads. |
| Data transfer | DMA directly into user-supplied buffer. No CPU cycles are used to copy data. | DMA into API allocated buffer, then copy to user-supplied buffer. CPU cycles used to copy data are not available to application threads. |
| DMA re-arm time | Next DMA started by hardware interrupt. Latency is lowest and data throughput is highest. | Next DMA started in polling loop. Latency is higher and data throughput is lower. |
| Master slave systems | Fully supported. | Not recommended. |

The synchronous AutoDMA API is deprecated; it is maintained for compatibility with existing applications. The asynchronous AutoDMA API is recommended for all new applications.

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#### 2.4.2.1 Traditional AutoDMA

Use traditional mode to acquire multiple records – one per trigger event – with sample points after, and optionally before, the trigger event in each record. A record header may optionally precede each record in the AutoDMA buffer. The programmer specifies the number of samples per record, records per buffer, and buffers in the acquisition.

Traditional AutoDMA supports low trigger repeat rates. For high trigger repeat rates, use NPT AutoDMA mode. Digitizers with four analog input channels do not support 3-channel operation, and require sample interleave to allow for high transfer rates from on-board memory.

Each buffer is organized in memory as follows if a board has on-board memory. Rxy represents a contiguous array of samples from record x of channel y.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A, R2A, R3A, … RnA |
| CH B | R1B, R2B, R3B … RnB |
| CH A and CH B | R1A, R1B, R2A, R2B, R3A, R3B … RnA, RnB |
| CH C | R1C, R2C, R3C … RnC |
| CH A and CH C | R1A, R1C, R2A, R2C, R3A, R3C … RnA, RnC |
| CH B and CH C | R1B, R1C, R2B, R2C, R3B, R3C … RnB, RnC |
| CH D | R1D, R2D, R3D … RnD |
| CH A and CH D | R1A, R1D, R2A, R2D, R3A, R3D … RnA, RnD |
| CH B and CH D | R1B, R1D, R2B, R2D, R3B, R3D … RnB, RnD |
| CH C and CH D | R1C, R1D, R2C, R2D, R3C, R3D … RnC, RnD |
| CH A, CH B, CH C and CH D | R1A, R1B, R1C, R1D, R2A, R2B, R2C, R2D, R3A, R3B, R3C, R3D … RnA, RnB, RnC, RnD |

Each buffer is organized in memory as follows if a board does not have on-board memory, or if sample interleave is enabled. Rxy represents a contiguous array of samples from record x of channel y, Rx[uv] represents interleaved samples from record x of channels u and v, and Rx[uvyz] represents interleaved samples from channels u, v, y, and z.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A, R2A, R3A, … RnA |
| CH B | R1B, R2B, R3B … RnB |
| CH A and CH B | R1[ABAB…], R2[ABAB…], … Rn[ABAB…] |
| CH C | R1C, R2C, R3C … RnC |
| CH A and CH C | R1[ACAC…], R2[ACAC…], … Rn[ACAC…] |
| CH B and CH C | R1[BCBC…], R2[BCBC…], … Rn[BCBC…] |
| CH D | R1D R2D, R3D … RnD |
| CH A and CH D | R1[ADAD…], R2[ADAD…], … Rn[ADAD…] |
| CH B and CH D | R1[BDBD…], R2[BDBD…], … Rn[BDBD…] |
| CH C and CH D | R1[CDCD…], R2[CDCD…], … Rn[CDCD…] |

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| | |
|---|---|
| CH A, CH B, CH C and CH C | R1[ABCDABDC …], R2[ABDCABDC …], … Rn[ABDCABDC…] |

See "%ATS_SDK_DIR%\Samples\DualPort\TR" for a sample program that demonstrates how to make an AutoDMA acquisition in Traditional mode.

If record headers are enabled, then a 16-byte record header will precede each record in an AutoDMA buffer. The record header contains a record timestamp, as well as acquisition metadata. See section 2.4.2.5 below for a discussion of AutoDMA record headers.

#### 2.4.2.2 NPT AutoDMA

Use NPT mode to acquire multiple records – one per trigger event – with no sample points before the trigger event in each record, and with no record headers. The programmer specifies the number of samples per record, records per buffer, and buffers in the acquisition.

Note that NPT mode is highly optimized, and supports higher trigger repeats rate than possible in Traditional mode. Digitizers with four analog input channels do not support 3-channel operation, and require sample interleave to allow for high transfer rates from on-board memory.

Each buffer is organized in memory as follows if a board has on-board memory. Rxy represents a contiguous array of samples from record x of channel y.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A, R2A, R3A, … RnA |
| CH B | R1B, R2B, R3B … RnB |
| CH A and CH B | R1A, R2A, R3A … RnA, R1B, R2B, R3B … RnB |
| CH C | R1C, R2C, R3C, … RnC |
| CH A and CH B | R1A, R2A, R3A … RnA, R1B, R2B, R3B … RnB |
| CH B and CH C | R1B, R2B, R3B … RnB, R1C, R2C, R3C … RnC |
| CH D | R1D, R2D, R3D, … RnD |
| CH A and CH D | R1A, R2A, R3A … RnA, R1D, R2D, R3D … RnD |
| CH B and CH D | R1B, R2B, R3B … RnB, R1D, R2D, R3D … RnD |
| CH C and CH D | R1C, R2C, R3C … RnC, R1D, R2D, R3D … RnD |
| CH A, CH B, CH C, and CH D | R1A, R2A, R3A … RnA, R1B, R2B, R3B … RnB, R1C, R2C, R3C … RnC, R1D, R2D, R3D … RnD |

Each buffer is organized in memory as follows if a board does not have on-board memory, or if sample interleave is enabled. Rxy represents a contiguous array of samples from record x of channel y, Rx[uv] represents interleaved samples from record x of channels u and v, and Rx[uvyz] represents interleaved samples from record x of channels u, v, y, and z.

| Enabled channels | Buffer organization |
|---|---|

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| | |
|---|---|
| CH A | R1A, R2A, R3A, … RnA |
| CH B | R1B, R2B, R3B … RnB |
| CH A and CH B | R1[ABAB…], R2[ABAB…], … Rn[ABAB…] |
| CH C | R1C, R2C, R3C … RnC |
| CH A and CH C | R1[ACAC…], R2[ACAC…], … Rn[ACAC…] |
| CH B and CH C | R1[BCBC…], R2[BCBC…], … Rn[BCBC…] |
| CH D | R1D R2D, R3D … RnD |
| CH A and CH D | R1[ADAD…], R2[ADAD…], … Rn[ADAD…] |
| CH B and CH D | R1[BDBD…], R2[BDBD…], … Rn[BDBD…] |
| CH C and CH D | R1[CDCD…], R2[CDCD…], … Rn[CDCD…] |
| CH A, CH B, CH C and CH C | R1[ABCDABDC …], R2[ABDCABDC …], … Rn[ABDCABDC…] |

See "%ATS_SDK_DIR%\Samples\DualPort\NPT" for a sample program that demonstrates how to make an AutoDMA acquisition in NPT mode.

#### 2.4.2.3 Continuous streaming AutoDMA

Use continuous streaming mode to acquire a single, gapless record that spans multiple buffers without waiting for a trigger event to start the acquisition. The programmer specifies the number of samples per buffer, and buffers per acquisition.

Each buffer is organized as follows if a board has on-board memory. R1x represents a contiguous array of samples from channel x.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A |
| CH B | R1B |
| CH A and CH B | R1A, R1B |
| CH C | R1C |
| CH A and CH C | R1A, R1C |
| CH B and CH C | R1B, R1C |
| CH D | R1D |
| CH A and CH D | R1A, R1D |
| CH B and CH D | R1B, R1D |
| CH C and CH D | R1C, R1D |
| CH A, CH B, CH C and CH D | R1A, R2B, R1C, R1D |

Each buffer is organized as follows if a board does not have on-board memory, or if sample interleave is enabled. R1x represents a contiguous array of samples from channel x, R1[uv] represents samples interleaved from channels u and v, and R1[uvyz] represents samples interleaved from channels u, v, y, and z.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A |
| CH B | R1B |

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| | |
|---|---|
| Both CH A and CH B | R1[ABAB…] |
| CH C | R1C |
| CH A and CH C | R1[ACAC…] |
| CH B and CH C | R1[BCBC…] |
| CH D | R1D |
| CH A and CH D | R1[ADAD…] |
| CH B and CH D | R1[BDBD…] |
| CH C and CH D | R1[CDCD…] |
| CH A, CH B, CH C and CH C | R1[ABCDABDC …] |

See "%ATS_SDK_DIR%\Samples\DualPort\CS" for a sample program that demonstrates how to make an AutoDMA acquisition in continuous streaming mode.

#### 2.4.2.4 Triggered streaming AutoDMA

Use triggered streaming mode to acquire a single, gapless record that spans two or more buffers after waiting for a trigger event to start the acquisition. The programmer specifies the number of samples in each buffer, and buffers in the acquisition.

Each buffer is organized as follows if a board has on-board memory. R1x represents a contiguous array of samples from channel x.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A |
| CH B | R1B |
| CH A and CH B | R1A, R1B |
| CH C | R1C |
| CH A and CH C | R1A, R1C |
| CH B and CH C | R1B, R1C |
| CH D | R1D |
| CH A and CH D | R1A, R1D |
| CH B and CH D | R1B, R1D |
| CH C and CH D | R1C, R1D |
| CH A, CH B, CH C and CH D | R1A, R2B, R1C, R1D |

Each buffer is organized as follows if a board does not have on-board memory, or if sample interleave is enabled. R1x represents a contiguous array of samples from channel x, R1[uv] represents samples interleaved from channels u and v, and R1[uvyz] represents samples interleaved from channels u, v, y, and z.

| Enabled channels | Buffer organization |
|---|---|
| CH A | R1A |
| CH B | R1B |
| Both CH A and CH B | R1[ABAB…] |
| CH C | R1C |
| CH A and CH C | R1[ACAC…] |

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| | |
|---|---|
| CH B and CH C | R1[BCBC…] |
| CH D | R1D |
| CH A and CH D | R1[ADAD…] |
| CH B and CH D | R1[BDBD…] |
| CH C and CH D | R1[CDCD…] |
| CH A, CH B, CH C and CH C | R1[ABCDABDC …] |

See "%ATS_SDK_DIR%\Samples\DualPort\TS" for a sample program that demonstrates how to make a triggered streaming AutoDMA acquisition.

#### 2.4.2.5 Record headers and timestamps

In traditional AutoDMA mode, a 16-byte record header may optionally precede each record in a buffer.

When record headers are enabled, the following table shows the buffer layout if a board has on-board memory. Record headers are not supported if a board does not have on-board memory. Rxy represents a contiguous array of samples from record x of channel y, and Hxy is a 16-byte record header from record x of channel y.

| Enabled channels | Buffer organization |
|---|---|
| CH A | H1A, R1A, H2A, R2A … HnA, RnA |
| CH B | H1B, R1B, H2B, R2B … HnB, RnB |
| CH A and CH B | H1A, R1A, H1B, R1B, H2A, R2A, H2B, R2B…<br>HnA, RnA, HnB, RnB |
| CH C | H1C, R1C, H2C, R2C … HnC, RnC |
| CH A and CH C | H1A, R1A, H1C, R1C, H2A, R2A, H2C, R2C…<br>HnA, RnA, HnC, RnC |
| CH B and CH C | H1B, R1B, H1C, R1C, H2B, R2B, H2C, R2C…<br>HnB, RnB, HnC, RnC |
| CH D | H1D, R1D, H2D, R2D … HnD, RnD |
| CH A and CH D | H1A, R1A, H1D, R1D, H2A, R2A, H2D, R2D…<br>HnA, RnA, HnD, RnD |
| CH B and CH D | H1B, R1B, H1D, R1D, H2B, R2B, H2D, R2D…<br>HnB, RnB, HnD, RnD |
| CH C and CH D | H1C, R1C, H1D, R1D, H2C, R2C, H2D, R2D…<br>HnC, RnC, HnD, RnD |
| CH A, CH B, CH C and CH D | H1A, R1A, H1B, R1B, H1C, R1C, H1D, R1D, H2A, R2A, H2B, R2B H2C, R2C, H2D, R2D…<br>HnA, RnA, HnB, RnB, HnC, RnC, HnD, RnD |

##### *2.4.2.5.1 Record headers*

A record header is a 16-byte structure defined in AlazarApi.h as follows:

```
struct _HEADER0 {
      unsigned int SerialNumber:18;        // bits 17..0
```

```
      unsigned int SystemNumber:4;          // bits 21..18
      unsigned int WhichChannel:1;          // bit 22
      unsigned int BoardNumber:4;           // bits 26..23
      unsigned int SampleResolution:3;      // bits 29..27
      unsigned int DataFormat:2;            // bits 31..30
};

struct _HEADER1 {
      unsigned int RecordNumber:24;         // bits 23..0
      unsigned int BoardType:8;             // bits 31..24
};

struct _HEADER2 {
      U32 TimeStampLowPart;                  //bits 31..0
};

struct _HEADER3 {
      unsigned int TimeStampHighPart:8;     // bits 7..0
      unsigned int ClockSource:2;           // bits 9..8
      unsigned int ClockEdge:1;             // bit 10
      unsigned int SampleRate:7;            // bits 17..11
      unsigned int InputRange:5;            // bits 22..18
      unsigned int InputCoupling:2;         // bits 24..23
      unsigned int InputImpedence:2;        // bits 26..25
      unsigned int ExternalTriggered:1;     // bit 27
      unsigned int ChannelBTriggered:1;     // bit 28
      unsigned int ChannelATriggered:1;     // bit 29
      unsigned int TimeOutOccurred:1;       // bit 30
      unsigned int ThisChannelTriggered:1; // bit 31
};

typedef struct _ALAZAR_HEADER {
      struct _HEADER0 hdr0;
      struct _HEADER1 hdr1;
      struct _HEADER2 hdr2;
      struct _HEADER3 hdr3;
} ALAZAR_HEADER, *PALAZAR_HEADER;
```

A record header contains the following fields:

| Field | Width in bits | Description |
|---|---|---|
| SerialNumber | 18 | Serial number of this board as a signed integer. |
| SystemNumber | 4 | System identifier number of this board system. |
| WhichChannel | 1 | Input channel of this header: 0 = CH A, 1 = CH B. |
| BoardNumber | 4 | Board identifier number of this board. |
| SampleResolution | 3 | Reserved |
| DataFormat | 2 | Reserved |
| RecordNumber | 24 | Index of record in acquisition. |
| BoardType | 8 | Board type identifier.<br>See AlazarGetBoardKind for a list of board type identifiers. |
| TimeStampLowPart | 32 | Lower 32 bits of 40-bit record timestamp. See section |

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| | | |
|---|---|---|
| | | 2.4.2.5.2 below. |
| TimeStampHighPart | 8 | Upper 8 bits of 40-bit record timestamp. See section 2.4.2.5.2 below. |
| ClockSource | 4 | Clock source identifier – 1.<br>See AlazarSetCaptureClock for a list of sample rate identifiers. |
| ClockEdge | 1 | Clock edge identifier.<br>See AlazarSetCaptureClock for a list of sample rate identifiers. |
| SampleRate | 7 | Sample rate identifier.<br>See AlazarSetCaptureClock for a list of sample rate identifiers. |
| InputRange | 5 | Input range identifier for this channel.<br>See AlazarInputControl for a list input range identifiers. |
| InputCoupling | 2 | Input coupling identifier for this channel.<br>See AlazarInputControl for a list input coupling identifiers. |
| InputImpedence | 2 | Input impedance identifier for this channel.<br>See AlazarInputControl for a list input impedance identifiers. |
| ExternalTriggered | 1 | This bit is set if TRIG IN on this board caused the board system to trigger and capture this record. Otherwise, this bit is cleared. |
| ChannelBTriggered | 1 | This bit is set if CH B on this board caused the board system to trigger and capture this record. Otherwise, this bit is cleared. |
| ChannelATriggered | 1 | This bit is set if CH A on this board caused the board system to trigger and capture this record. Otherwise, this bit is cleared. |
| TimeOutOccurred | 1 | This bit is set if a trigger timeout expired on a trigger engine on this board caused the board system to trigger and capture this record. Otherwise, this bit is cleared. |
| ThisChannelTriggered | 1 | This bit is set if the channel specified by the WhichChannel field on this board caused the board system to trigger and capture this record. Otherwise, this bit is cleared. |

See "%ATS_SDK_DIR%\Samples\DualPort\TR_Header" for a full sample program that demonstrates how to make an AutoDMA acquisition in Traditional mode with record headers.

#### *2.4.2.5.2 Record timestamps*

AlazarTech digitizer boards include a high-speed 40-bit counter that is clocked by the sample clock source scaled by a board specific divider. When a board receives a trigger event to capture a record to on-board memory, it latches the value of this counter. This

timestamp value gives the time, relative to when the counter was reset, when the trigger event for this record occurred.

By default, this counter is reset to zero at the start of each acquisition. Use AlazarResetTimeStamp to control when the record timestamp counter is reset.

The following code fragment demonstrates how to extract the timestamp from a record header, and covert the value from counts to seconds.

```
double samplesPerTimestampCount = 2;     // board specific constant
double samplesPerSec = 100.e6;           // sample rate

void* pRecord;  // points to record header in buffer
ALAZAR_HEADER *pHeader = (ALAZAR_HEADER*) pRecord;

__int64 timestamp_counts;
timestamp_counts = (INT64) pHeader->hdr2.TimeStampLowPart;
timestamp_counts = timestamp_counts |
    (((__int64) (pHeader->hdr3.TimeStampHighPart & 0x0ff)) << 32);

double timestamp_sec = samplesPerTimestampCount *
    timestamp_counts / samplesPerSec;
```

Call AlazarGetParameter with the GET_SAMPLES_PER_TIMESTAMP_CLOCK parameter to determine the board specific "samples per timestamp count" value. The following table lists these values.

| Model | Samples per timestamp count |
|---|---|
| ATS310, ATS330,<br>ATS460, ATS660,<br>ATS9462,<br>ATS9850, ATS9870,<br>ATS9325, ATS9350, ATS951 | 2 |
| ATS850, ATS860<br>ATS9625, ATS8626 | 4 |
| ATS9440 | 1 |

See "%ATS_SDK_DIR%\Samples\DualPort\TR_Header" for a full sample program that demonstrates how to make an AutoDMA acquisition in Traditional mode with record headers, and convert the timestamp to seconds.

#### 2.4.2.6 Using asynchronous AutoDMA

The asynchronous AutoDMA functions allow an application to add user-defined number of buffers to a list of buffers available to be filled by a board, and to wait for the board to receive sufficient trigger events to fill the buffers with sample data. The board uses AutoDMA to transfer data directly into a buffer without making any intermediate copies in memory. As soon as one buffer is filled, the driver automatically starts an AutoDMA transfer into the next available buffer.

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#### *2.4.2.6.1 AlazarPostBuffer*

C/C++ applications should call AlazarPostAsyncBuffer to make buffers available to be filled by the board, and AlazarWaitAsyncBufferComplete to wait for the board to receive sufficient trigger events to fill the buffers.

The following code fragment outlines the steps required to make an AutoDMA acquisition using AlazarPostAsyncBuffer and AlazarWaitAsyncBufferComplete.

```
// Configure the board to make an AutoDMA acquisition

AlazarBeforeAsyncRead(
    handle,                 // HANDLE -- board handle
    channelMask,            // U32 -- enabled channel mask
    -(long)preTriggerSamples,   // long -- trigger offset
    samplesPerRecord,       // U32 -- samples per record
    recordsPerBuffer,       // U32 -- records per buffer
    recordsPerAcquisition,  // U32 -- records per acquisition
    flags                   // U32 -- AutoDMA mode and options
    );

// Add two or more buffers to a list of buffers
// available to be filled by the board

for (i = 0; i < BUFFER_COUNT; i++)
{
    AlazarPostAsyncBuffer(
        handle,             // HANDLE -- board handle
        BufferArray[i],     // void* -- buffer pointer
        BytesPerBuffer      // U32 -- buffer length in bytes
        );
}

// Arm the board to begin the acquisition

AlazarStartCapture(handle);

// Wait for each buffer in the acquisition to be filled

U32 buffersCompleted = 0;
while (buffersCompleted < buffersPerAcquisition)
{
    // Wait for the board to receives sufficient trigger events
    // to fill the buffer at the head of its list of
    // available buffers.

    U32 bufferIndex = buffersCompleted % BUFFER_COUNT;
    U16* pBuffer = BufferArray[bufferIndex];
    AlazarWaitAsyncBufferComplete(handle, pBuffer, timeout_ms);
    buffersCompleted++;

    // The buffer is full, process it.
    // Note that while the application processes this buffer,
    // the board is filling the next available buffer
    // as trigger events arrive.
```

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```
        ProcessBuffer(pBuffer, bytesPerBuffer);

        // Add the buffer to the end of the list of buffers
        // available to be filled by this board. The board will
        // fill it with another segment of the acquisition after
        // all of the buffers preceding it have been filled.

        AlazarPostAsyncBuffer(handle, pBuffer, bytesPerBuffer);
    }

    // Abort the acquisition and release resources.
    // This function must be called after an acquisition.

    AlazarAbortAsyncRead(boardHandle);
```

See "%ATS_SDK_DIR%\Samples\DualPort\NPT" for a full sample program that demonstrates make an AutoDMA acquisition using AlazarPostAsyncBuffer.

#### *2.4.2.6.2 ADMA_ALLOC_BUFERS*

C#, Visual Basic, and LabVIEW applications may find it more convenient to allow the API to allocate and manage a list of buffers available to be filled by the board. These applications should call AlazarBeforeAsyncRead with the AMDA_ALLOC_BUFFERS option selected in the "Flags" parameter.

This option will cause the API to allocate and manage a list of buffers available to be filled by the board. The application must call AlazarWaitNextAsyncBufferComplete to wait for a buffer to be filled. When the board receives sufficient trigger events to fill a buffer, the API will copy the data from the internal buffer to the user-supplied buffer.

The following code fragment outlines how make an AutoDMA acquisition using ADMA_ALLOC_BUFERS flag and AlazarWaitNextAsyncBufferComplete.

```
    // Allow the API to allocate and manage AutoDMA buffers

    flags |= ADMA_ALLOC_BUFFERS;

    // Configure a board to make an AutoDMA acquisition

    AlazarBeforeAsyncRead(
        handle,                 // HANDLE -- board handle
        channelMask,            // U32 -- enabled channel mask
        -(long)preTriggerSamples,   // long -- trigger offset
        samplesPerRecord,       // U32 -- samples per record
        recordsPerBuffer,       // U32 -- records per buffer
        recordsPerAcquisition,  // U32 -- records per acquisition
        flags                   // U32 -- AutoDMA mode and options
        );

    // Arm the board to begin the acquisition

    AlazarStartCapture(handle);

    // Wait for each buffer in the acquisition to be filled
```

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```
RETURN_CODE retCode = ApiSuccess;
while (retCode == ApiSuccess)
{
    // Wait for the board to receive sufficient
    // trigger events to fill an internal AutoDMA buffer.
    // The API will copy data from the internal buffer
    // to the user-supplied buffer.

    retCode =
        AlazarWaitNextAsyncBufferComplete(
            handle,          // HANDLE -- board handle
            pBuffer,         // void* -- buffer to receive data
            bytesToCopy,     // U32 -- bytes to copy into buffer
            timeout_ms       // U32 -- time to wait for buffer
            );

    // The buffer is full, process it
    // Note that while the application processes this buffer,
    // the board is filling the next available internal buffer
    // as trigger events arrive.

    ProcessBuffer(pBuffer, bytesPerBuffer);
}

// Abort the acquisition and release resources.
// This function must be called after an acquisition.

AlazarAbortAsyncRead(boardHandle);
```

See "%ATS_SDK_DIR%\Samples\DualPort\CS_WaitNextBuffer" for a full sample program that demonstrates make an AutoDMA acquisition using ADMA_ALLOC_BUFFERS.

An application can get or set the number of DMA buffers allocated by the API by calling AlazarGetParameter or AlazarSetParameter with the parameter SETGET_ASYNC_BUFFCOUNT.

Note that applications may combine ADMA_ALLOC_BUFFERS with options to perform operations that would be difficult in high-level programming languages like LabVIEW. They include:

- Data normalization – This option enables the API to process sample data so that the data always has the same arrangement in the application buffer, independent of AutoDMA mode. See ADMA_GET_PROCESSED_DATA for more information.
- Disk streaming – This option allows the API to use high-performance disk I/O functions to stream buffer data to files. See AlazarCreateStreamFile below for more information.

#### *2.4.2.6.3 AlazarAsyncRead*

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Some C/C++ applications under Windows may require waiting for an event to be set to the signaled state to indicate when an AutoDMA buffer is full. These applications should use the AlazarAsyncRead API.

The following code fragment outlines how use AlazarAsyncRead to make an asynchronous AutoDMA acquisition.

```
// Configure the board to make an AutoDMA acquisition

AlazarBeforeAsyncRead(
    handle,                 // HANDLE -- board handle
    channelMask,            // U32 -- enabled channel mask
    -(long)preTriggerSamples,   // long -- trigger ofset
    samplesPerBuffer,       // U32 -- samples per buffer
    recordsPerBuffer,       // U32 -- records per buffer
    recordsPerAcquisition,  // U32 -- records per acquisition
    admaFlags               // U32 -- AutoDMA flags
    );

// Add two or more buffers to a list of buffers
// available to be filled by the board

for (i = 0; i < BUFFER_COUNT; i++)
{
    AlazarAsyncRead (
        handle,                         // HANDLE -- board handle
        IoBufferArray[i].buffer,        // void* -- buffer
        IoBufferArray[i].bytesPerBuffer, // U32 -- buffer length
        &IoBufferArray[i].overlapped    // OVERLAPPED*
        );
}

// Arm the board to begin the acquisition

AlazarStartCapture(handle);

// Wait for each buffer in the acquisition to be filled.

U32 buffersCompleted = 0;
while (buffersCompleted < buffersPerAcquisition)
{
    // Wait for the board to receives sufficient
    // trigger events to fill the buffer at the head of its
    // list of available buffers.
    // The event handle will be set to the signaled state when
    // the buffer is full.

    U32 bufferIndex = buffersCompleted % BUFFER_COUNT;
    IO_BUFFER *pIoBuffer = IoBufferArray[bufferIndex];

    WaitForSingleObject(pIoBuffer->hEvent, INFINTE);
    buffersCompleted++;

    // The buffer is full, process it
    // Note that while the application processes this buffer,
```

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```
        // the board is filling the next available buffer
        // as trigger events arrive.

        ProcessBuffer(pIoBuffer->buffer, pIoBuffer->bytesPerBuffer);

        // Add the buffer to the end of the list of buffers.
        // The board will fill it with another segment from the
        // acquisition after the buffers preceding it have been filled.

        AlazarAsyncRead (
            handle,                     // HANDLE -- board handle
            pIoBuffer->buffer,          // void* -- buffer
            pIoBuffer->bytesPerBuffer,  // U32 -- buffer length
            &pIoBuffer->overlapped      // OVERLAPPED*
            );
    }

    // Stop the acquisition.
    // This function must be called if unfilled buffers are pending.

    AlazarAbortAsyncRead(handle);
```

See "%ATS_SDK_DIR%\Samples\DualPort\CS_AsyncRead" for a full sample program that demonstrates make an AutoDMA acquisition using AlazarAsyncRead.

#### *2.4.2.6.4 AlazarAbortAsyncRead*

The asynchronous API driver locks application buffers into memory so that boards may DMA directly into them. When a buffer is completed, the driver unlocks it from memory.

An application must call AlazarAbortAsyncRead if, at the end of an acquisition, any of the buffers that it supplies to a board have not been completed. AlazarAbortAsyncRead completes any pending buffers, and unlocks them from memory.

If an application exits without calling AlazarAbortAsyncRead, the API driver may generate a DRIVER_LEFT_LOCKED_PAGES_IN_PROCESS (0x000000CB) bug check error under Windows, or leak the locked memory under Linux.

This may happen, for example, if a programmer runs an application that uses the API under a debugger, stops at a breakpoint, and then stops the debugging session without letting the application or API exit normally.

#### *2.4.2.6.5 Buffer count*

An application should supply at least two buffers to a board. This allows the board to fill one buffer while the application consumes the other. As long as the application can consume buffers faster than the board can fill them, the acquisition can continue indefinitely.

However, Microsoft Windows and general-purpose Linux distributions are not real time operating systems. An application thread may be suspended for an indeterminate amount of time to allow other threads with higher priority to run. As a result, buffer processing

may take longer than expected.

The board is filling AutoDMA buffers with sample data in real time. If an application is unable to supply buffers as fast a board fills them, the board will run out of buffers into which it can transfer sample data. The board can continue to acquire data until it fills is on-board memory, but then it will abort the acquisition and report a buffer overflow error.

It is recommended that an application supply three or more buffers to a board. This allows some tolerance for operating system latencies. The programmer may need to increase the number of buffers according to the application.

Note that the number of buffers required by a board is not the same as the number of buffers required by an application. There may be little benefit in supplying a board with more than a few tens of buffers, each of a few million samples. If an application requires much more sample data for data analysis or other purposes, the programmer should consider managing application buffers separately from AutoDMA buffers.

#### 2.4.2.7 Using synchronous AutoDMA

Synchronous DMA API assumes that the PCI digitizer being controlled has dual-port acquisition memory.

As shown below, the user program consumes data synchronously with the acquisition loop. Hence the name Synchronous DMA.

A typical sequence of API calls for Synchronous DMA API is shown below. For readability purposes, the following is pseudo-code. Please refer to the sample programs provided for exact syntax and details of what the various parameters passed to these routines mean:

```
// Set up two AutoDMA buffers and start the DMA engine
// Data will be captured in the two buffers in a pin-pong
// mode.  You will be able to process the first buffer while
// data is being captured into the second buffer and
// vice-versa

AlazarStartAutoDMA(h,
                   UserData[0],
                   UseHeader,
                   mode,
                   -(long)bd.PreDepth,
                   transferLength,
                   RecsPerBuffer,
                   bd.RecordCount,
                   &error,
                   CFlags,
                   in1,
                   &r3,
                   &r4);
```

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```
// Issue Start Capture Command. No data transfer happens before this

AlazarStartCapture( h );


// Wait until all required records have been captured

while (looping == 1)
{
   // Check if one of the AutoDMA buffers has been
   // fully populated or not

   AlazarGetNextAutoDMABuffer(h,
                              UserData[0],
                              UserData[1],
                              &WhichOne,
                              &RecsTransferred ,
                              &error,
                              in1,
                              in1,
                              &TriggersOccurred,
                              &r4);

   // If WhichOne is equal to 0 or 1, that particular buffer
   // has been populated and hardware is DMAing
   // into the other buffer

   if ((WhichOne == 0)||(WhichOne == 1))
   {
      // Process Your Data here
      // Note that while you process data,
      // new data is still being captured into
      // on-board dual port memory and transferred into
      // the other AutoDMA buffer

      SaveToChannelFiles(UserData[WhichOne]);
   }

   // Check if all records have been captured
   if (RecsTransferred == (long)RecordCount)
   {
      // If all records have been captured, stop the while loop
      looping = 0;
   }
}
```

Note:

- The synchronous AutoDMA API is deprecated, and is maintained for compatibility with existing applications.
- The synchronous AutoDMA API gives poor performance with master-slave systems, and is not recommended for use with such systems.
- Use the CFlags parameter in the call to AlazarStartAutoDMA to select the AutoDMA mode.

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- Record headers are only available in Traditional AutoDMA mode. To enable record headers, call AlazarStartAutoDMA with the UseHeader parameter set to 1, and with the mode in the CFlags parameter set to ADMA_TRADITIONAL_MODE.
- AlazarGetNextAutoDMABuffer copies sample data from internally allocated AutoDMA buffers to an application buffer. An application may call this function with a pointer to a single application allocated buffer, rather than two application allocated buffers (Buffer[0] and Buffer[1] above) without affecting AutoDMA operation.
- Calling AlazarWaitNextAsyncBufferComplete in a polling loop is equivalent to calling AlazarEvents, AlazarWaitForBufferReady, and AlazarGetNextAutoDMABuffer, but provides more internally allocated buffers, better throughput, and a simpler programming interface.

#### 2.4.2.8 Scanning applications

Scanning applications divide an acquisition into frames, where each frame is composed of a number of scan lines, and each scan line is composed of a number of sample points.

These applications typically:

- Wait for a "start of frame" event.
- Wait for a number of "start of line" events, capturing a specified number of sample points after each "start of line" event.
- Wait for the next "start of frame" event and repeat.

To implement a scanning application using a hardware "start of frame" signal:

- Connect a TTL signal that will serve as the "start of frame" event to the AUX I/O connector.
- Call AlazarConfigureAuxIO specifying AUX_IN_TRIGGER_ENABLE as the mode, and the active edge of the trigger enable signal as the parameter.
- Configure the board to make an NPT or Traditional mode AutoDMA acquisition where the number of "records per buffer" is equal to the number of scan lines per frame.
- Call AlazarStartCapture to being the acquisition.
- Supply a TTL pulse to the AUX I/O connector (or call AlazarForceTriggerEnable) to arm the board to capture one frame. The board will wait for sufficient trigger events to capture the number of records in an AutoDMA buffer, and then wait for the next trigger enable event.

To implement a scanning application using a software "start of frame" command:

- Call AlazarConfigureAuxIO specifying AUX_OUT_TRIGGER_ENABLE as the mode, along with the signal to output on the AUX I/O connector.
- Configure the board to make an NPT or Traditional mode AutoDMA acquisition where the number of "records per buffer" is equal to the number of scan lines per frame.
- Call AlazarStartCapture to being the acquisition.

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- Call AlazarForceTriggerEnable to arm the board to capture one frame. The board will wait for sufficient trigger events to capture the number of records in an AutoDMA buffer, and then wait for the next trigger enable event.

Note that if the number of records per acquisition is set to infinite, software arms the digitizer once to make an AutoDMA acquisition with an infinite number of frames. The hardware will continue acquiring frame data until the acquisition is aborted.

See "%ATS_SDK_DIR%\Samples\DualPort\NPT_Scan" for sample programs that demonstrate how to make a scanning application using hardware trigger enable signals.

If the application configures a digitizer to use an external clock source, and the clock source becomes invalid during horizontal retrace intervals, then the application should consider enabling the "dummy clock" option if supported by the board.

When the "dummy clock" option enabled, the digitizer uses an internally generated clock signal to drive its ADCs for a specified amount of time after the end of each record. At the end of the dummy clock on time, the digitizer switches back to using the external clock signal to clock the ADCs.

The application should configure the dummy clock to be used during the horizontal retrace period after each scan line. See paragraph 2.3.1.5 Dummy clock for more information.

If an application uses both external clock and external trigger inputs, and the clock source becomes invalid during horizontal retrace intervals, the application should call AlazarSetTriggerOperationForScanning to configure the trigger engines for an external clock source, and to synchronize the start of an acquisition with the next external trigger event after the call to AlazarStartCapture, when the external clock signal is valid. For more information see paragraph 2.3.3.6 AlazarSetTriggerOperationForScanning.

#### 2.4.2.9 Master-slave applications

If a dual-port acquisition API is used to acquire from master-slave board system:

- Call AlazarBeforeAsyncRead on all slave boards before the master board.
- Call AlazarStartCapture only on the master board.
- Call AlazarAbortAsyncRead on the master board before the slave boards.
- The board system acquires the boards in the board system in parallel. As a result, an application must consume a buffer from each board in the board system during each cycle of the acquisition loop.
- Do not use synchronous API functions with master-slave systems – use the asynchronous API functions instead.

The following sample programs demonstrate how to acquire from a master-slave system: "%ATS_SDK_DIR%\Samples\DualPort\TR_MS", "%ATS_SDK_DIR

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%\Samples\DualPort\NPT_MS", "%ATS_SDK_DIR%\Samples\DualPort\CS_MS", and "%ATS_SDK_DIR%\Samples\DualPort\TS_MS".

### 2.4.3 Buffer size and alignment

AlazarTech digitizer boards must be configured to acquire a minimum number of samples per record, and each record must be a multiple of a specified number of samples. Records may shift within a buffer if aligment requirements are not met.

The following table lists the requirements for each board model.

| Board type | Minimum record size (samples) | Pretrigger alignment (samples) | Buffer alignment (samples) | Buffer alignment in NPT mode (samples) |
|---|---|---|---|---|
| ATS310 | 256 | 4 | 16 | Not supported |
| ATS330 | 256 | 4 | 16 | Not supported |
| ATS460 | 128 | 16 | 16 | 32 |
| ATS660 | 128 | 16 | 16 | 32 |
| ATS850 | 256 | 4 | 4 | Not supported |
| ATS860 | 256 | 32 | 32 | 64 |
| ATS9325 | 256 | 32 | 32 | 32 |
| ATS9350 | 256 | 32 | 32 | 32 |
| ATS9351 | 256 | 32 | 32 | 32 |
| ATS9360 | 256 | 32 | 32 | 32 |
| ATS9462 | 256 | 32 | 32 | 32 |
| ATS9625 | 256 | 32 | 32 | 32 |
| ATS9626 | 256 | 32 | 32 | 32 |
| ATS9850 | 256 | 64 | 64 | 64 |
| ATS9870 | 256 | 64 | 64 | 64 |
| ATS9440 | 256 | 32 | 32 | 32 |

The number of pre-trigger samples in single-port and dual-port "traditional" AutoDMA mode must be a multiple of the pre-trigger aligment value above. See AlazarSetRecordCount and AlazarSetRecordSize for more information.

The address of application buffers passed to the following data transfer functions must meet the buffer aligment requirement in the table above: AlazarRead, AlazarReadEx, AlazarAsyncRead, AlazarPostAsyncBuffer, and AlazarWaitAsyncBufferComplete. For example, the address of a buffer passed to AlazarPostAsyncBuffer to receive data from an ATS9350 must be aligned to a 32-sample, or 64-byte, address.

Note that AlazarWaitNextAsyncBufferComplete has no aligment requirements. As a result, an application can use this function to transfer data if it is impossible to allocate correctly aligned buffers.

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### 2.4.4 Data format

By default, AlazarTech digitizers generate unsigned sample data. For example, 8-bit digitizers such as the ATS9870 generate sample codes between 0 and 255 (0xFF) where: 0 represents a negative full-scale input voltage, 128 (0x80) represents ~0V input voltage, 255 (0xFF) represents a positive full-scale input voltage.

Some AlazarTech digitizer can be configured to generate signed sample data in two's complement format. For example, the ATS9870 can be configured to generate sample codes where: 0 represents ~0V input voltage, 127 (0x7F) represents a positive full-scale input voltage, and –128 (0x80) represents a negative full-scale input voltage.

Call AlazarSetParameter with parameter SET_DATA_FORMAT before the start of an acquisition to set the sample data format, and call AlazarGetParameter with GET_DATA_FORMAT to get the current data format.

The following code fragment demonstrates how to select signed sample data output.

```
AlazarSetParameter(
    handle,             // HANDLE -- board handle
    0,                  // U8 -- channel Id (not used)
    SET_DATA_FORMAT,    // U32 -- parameter to set
    DATA_FORMAT_SIGNED // long -- value (0 = unsigned, 1 = signed)
    );
```

## 2.5 Processing data

### 2.5.1 Converting samples values to volts

The data acquisition API's transfer an array of sample values into an application buffer. Each sample value occupies 1 or 2 bytes in the buffer, where a sample code is stored in the most significant bits of the sample values. Sample values that occupy two bytes are stored with their least significant bytes at the lower byte addresses (little-endian byte order) in the buffer.

To convert sample values in the buffer to volts:

- Get a sample value from the buffer.
- Get the sample code from the most-significant bits of the sample value.
- Convert the sample code to volts.

Note that the arrangement of samples values in the buffer into records and channels depends on the API used to acquire the data.

- Single-port acquisitions return a contiguous array of samples for a specified channel. (See section 2.4.1 "Single-port acquisitions" above.)
- Dual-port AutoDMA acquisitions return sample data whose arrangement depends on the AutoDMA mode and options chosen. (See section 2.4.2 "Dual port AutoDMA" above.)

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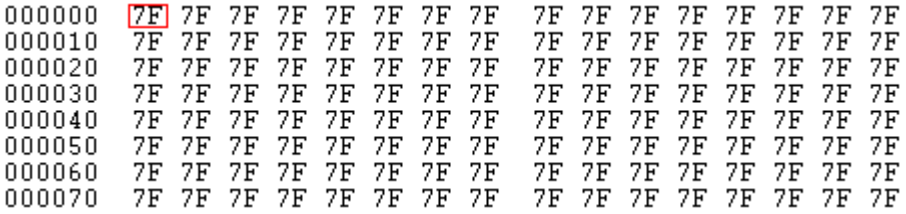
Also note that AlazarTech digitizer boards generate unsigned sample codes by default. (See section 2.4.3 "Data format" above.)

#### 2.5.1.1 8-bits per sample

##### *2.5.1.1.1 Getting 1-byte sample values from the buffer*

The figure below shows the first 128-bytes of data in a buffer from an 8-bit digitizer such as the ATS850, ATS860, ATS9850, and ATS9870.

**Figure 2-6 8-bit sample data**




Each 8-bit sample occupies 1-byte in the buffer, so the figure displays 128 samples (128 bytes / 1 byte per sample).

The following code fragment demonstrates how to access each 8-bit sample value in a buffer.

```
U8 *pSamples = (U8*) buffer;
for (U32 sample = 0; sample < samplesPerBuffer; sample++)
{
   U8 sampleValue = *pSamples++;
   printf("sample value = %02X\n", sampleValue);
}
```

##### *2.5.1.1.2 Getting 8-bit sample codes from 1-byte sample values*

Each 8-bit sample value stores an 8-bit sample code. For example, the first byte in buffer above stores the sample code 0x7F, or 127 decimal.

##### *2.5.1.1.3 Converting unsigned 8-bit sample codes to volts*

A sample code of 128 (0x80) represents ~0V input voltage, 255 (0xFF) represents a positive full-scale input voltage, and 0 represents a negative full-scale input voltage.

The following table illustrates how unsigned 8-bit sample codes map to values in volts according to the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| 0 | 0x00 | -100% | -100 mV | -1 V |
| 64 | 0x40 | -50% | -50 mV | -.5 V |

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| | | | | |
|---|---|---|---|---|
| 128 | 0x80 | 0% | 0 V | 0V |
| 192 | 0xC0 | +50% | 50 mV | +.5 V |
| 255 | 0xFF | +100% | +100 mV | +1 V |

The following code fragment shows how to convert a 1-byte sample value containing an unsigned 8-bit code to in volts.

```
double SampleToVoltsU8(U8 sampleValue, double inputRange_volts)
{
    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 8;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleValue - codeZero) / codeRange);

    return sampleVolts;
}
```

#### *2.5.1.1.4 Converting signed 8-bit sample codes to volts*

A signed code of 0 represents ~0V input voltage, 127 (0x7F) represents a positive full-scale input voltage, and –128 (0x80) represents a negative full-scale input voltage.

The following table illustrates how signed 8-bit sample codes map to values in volts according to the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| -127 | 0x81 | -100% | -100 mV | -1 V |
| -64 | 0xC0 | -50% | -50 mV | -.5 V |
| 0 | 0x00 | 0% | 0 V | 0V |
| 64 | 0x40 | +50% | 50 mV | +.5 V |
| 127 | 0x7F | +100% | +100 mV | +1 V |

The following code fragment shows how to convert a 1-byte sample value containing a signed 8-bit sample code to in volts.

```
double SampleToVoltsS8(U8 sampleValue, double inputRange_volts)
{
    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 8;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert signed code to unsigned
    U8 sampleCode = sampleValue + 0x80;
```

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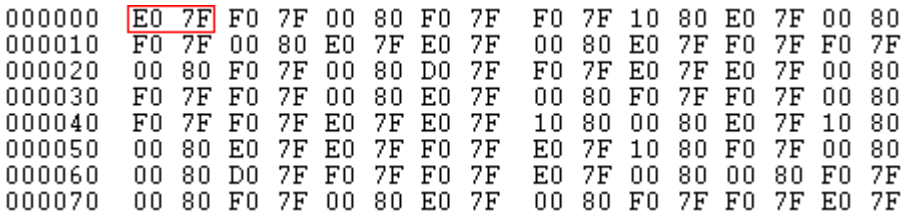
```
    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

### 2.5.1.2 12-bits per sample

#### *2.5.1.2.1 Getting 2-byte sample values from the buffer*

The figure below displays the first 128-bytes of data in a buffer from a 12-bit digitizer such as the ATS310, ATS330, ATS9325, ATS9350, ATS9351, and ATS9360.

**Figure 2-7 12-bit sample data**




Each 12-bit sample value occupies a 2-bytes in the buffer, so the figure displays 64 sample values (128 bytes / 2 bytes per sample).

The first 2 bytes in the buffer, shown highlighted, are 0xE0 and 0x7F. Two-byte sample values are stored in little-endian byte order in the buffer, so the first sample value in the buffer is 0x7FE0.

The following code fragment demonstrates how to access each 16-bit sample value in a buffer.

```
U16 *pSamples = (U16*)buffer;
for (U32 sample = 0; sample < samplesPerBuffer; sample++)
{
   U16 sampleValue = *pSamples++;
   printf("sample value = %04X\n", sampleValue);
}
```

#### *2.5.1.2.2 Getting 12-bit sample codes from 16-bit sample values*

A12-bit sample code is stored in the most significant bits of each 16-bit sample value, so right-shift each 16-bit value by 4 (or divide by 16) to obtain the 12-bit sample code. In the example above, the 16-bit sample value 0x7FE0 right-shifted by four results in the 12-bit sample code 0x7FE, or 2046 decimal.

| | |
|---|---|
| 16-bit sample value in decimal | 32736 |
| 16-bit sample value in hex | 7FE0 |
| 16-bit sample value in binary | 0111 1111 1110 0000 |

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| | |
|---|---|
| 12-bit sample code from most-significant bits of 16-bit sample value | 0111 1101 1110 |
| 12-bit sample code in hex | 7FE |
| 12-bit sample code in decimal | 2046 |

#### *2.5.1.2.3 Converting unsigned 12-bit sample codes to volts*

An unsigned code of 2048 (0x800) represents ~0V input voltage, 4095 (0xFFF) represents a positive full-scale input voltage, and 0 represents a negative full-scale input voltage.

The following table illustrates how unsigned 12-bit sample codes map to values in volts according to the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| 0 | 0x000 | -100% | -100 mV | -1 V |
| 1024 | 0x400 | -50% | -50 mV | -.5 V |
| 2048 | 0x800 | 0% | 0 V | 0V |
| 3072 | 0xC00 | +50% | 50 mV | +.5 V |
| 4095 | 0xFFF | +100% | +100 mV | +1 V |

The following code fragment demonstrates how to convert a 2-byte word containing an unsigned 12-bit sample code to in volts.

```
double SampleToVoltsU12(U16 sampleValue, double inputRange_volts)
{
    // Right-shift 16-bit sample word by 4 to get 12-bit sample code
    int bitShift = 4;
    U16 sampleCode = sampeValue >> bitShift;

    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 12;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

#### *2.5.1.2.4 Converting signed 12-bit sample codes to volts*

A signed code of 0 represents ~0V input voltage, 2047 (0x7FF) represents a positive full-scale input voltage, and -2048 (0x800) represents a negative full-scale input voltage.

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The following table illustrates how signed 12-bit sample codes map to values in volts according to the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| -2047 | 0x801 | -100% | -100 mV | -1 V |
| -1024 | 0xC00 | -50% | -50 mV | -.5 V |
| 0 | 0x000 | 0% | 0 V | 0V |
| 1024 | 0x400 | +50% | 50 mV | +.5 V |
| 2047 | 0x7FF | +100% | +100 mV | +1 V |

The following code fragment shows how to convert a 2-byte sample word containing a signed 12-bit sample code to in volts.

```
double SampleToVoltsS12(U16 sampleValue, double inputRange_volts)
{
    // Right-shift 16-bit sample value by 4 to get 12-bit sample code
    int bitShift = 4;
    U16 sampleCode = sampleValue >> bitShift;

    // Convert signed code to unsigned
    sampleCode = (sampleCode + 0x800) & 0x7FF;

    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 12;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

### 2.5.1.3 14-bits per sample

#### *2.5.1.3.1 Getting 2-byte sample values from the buffer*

The figure below displays the first 128-bytes of data in a buffer from a 14-bit digitizer such as the ATS460 and ATS9440.

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**Figure 2-8 14-bit sample data**

```
000000  4C 7F EC 7F 3C 80 98 80  D0 80 24 81 7C 81 B4 81
000010  3C 82 B4 82 A8 82 60 83  9C 83 14 84 40 84 88 84
000020  E0 84 50 85 D0 85 FC 85  2C 86 B0 86 10 87 58 87
000030  AC 87 10 88 38 88 CC 88  30 89 94 89 98 89 30 8A
000040  44 8A D8 8A 64 8B C8 8B  B4 8B 34 8C 78 8C B0 8C
000050  28 8D 94 8D D8 8D 40 8E  90 8E C4 8E 6C 8F 3C 8F
000060  04 90 C8 8F 40 8F E8 8E  B0 8E 74 8E E0 8D B4 8D
000070  48 8D E8 8C 98 8C 2C 8C  F4 8B 70 8B 3C 8B FC 8A
```

Each sample value occupies a 2-bytes in the buffer, so the figure displays 64 sample values (128 bytes / 2 bytes per sample).

The first 2 bytes in the buffer, shown highlighted, are 0x4C and 0x7F. Two-byte sample values are stored in little-endian byte order in the buffer, so the first sample value in the buffer is 0x7F4C.

The following code fragment demonstrates how to access each 16-bit sample value in a buffer.

```
U16 *pSamples = (U16*) buffer;
for (U32 sample = 0; sample < samplesPerBuffer; sample++)
{
   U16 sampleValue = *pSamples++;
   printf("sample value = %04X\n", sampleValue);
}
```

#### *2.5.1.3.2 Getting 14-bit sample codes from 16-bit sample values*

A 14-bit sample code is stored in the most significant bits of each 16-bit sample value in the buffer, so right-shift each 16-bit value by 2 (or divide by 4) to obtain the 14-bit sample code. In the example above, the 16-bit value 0x7F4C right-shifted by two results in the 14-bit sample code 0x1FD3, or 8147 decimal.

| | |
|---|---|
| 16-bit sample value in decimal | 32588 |
| 16-bit sample value in hex | 7F4C |
| 16-bit sample value in binary | 0111 1111 0100 1100 |
| 14-bit sample code from most-significant bits of 16-bit sample value | 01 1111 1101 0011 |
| 14-bit sample code in hex | 1FD3 |
| 14-bit sample code in decimal | 8147 |

#### *2.5.1.3.3 Converting unsigned 14-bit sample codes to volts*

An unsigned code of 8192 (0x2000) represents ~0V input voltage, 16383 (0x3FFF) represents a positive full-scale input voltage, and 0 represents a negative full-scale input voltage.

The following table illustrates how unsigned 14-bit sample codes map to values in volts according to the full-scale input range of an input channel.

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| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| 0 | 0x0000 | -100% | -100 mV | -1 V |
| 4096 | 0x1000 | -50% | -50 mV | -.5 V |
| 8192 | 0x2000 | 0% | 0 V | 0V |
| 12288 | 0x3000 | +50% | 50 mV | +.5 V |
| 16383 | 0x3FFF | +100% | +100 mV | +1 V |

The following code fragment demonstrates how to convert a 2-byte sample value containing an unsigned 14-bit sample code to in volts.

```
double SampleToVoltsU14(U16 sampleValue, double inputRange_volts)
{
    // Right-shift 16-bit sample word by 2 to get 14-bit sample code
    int bitShift = 2;
    U16 sampleCode = sampleValue >> bitShift;

    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 14;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

#### *2.5.1.3.4 Converting signed 14-bit sample codes to volts*

A signed code of 0 represents ~0V input voltage, 8191 (0x1FFF) represents a positive full-scale input voltage, and –8192 (0x2000) represents a negative full-scale input voltage.

The following table illustrates how signed 14-bit sample codes map to values in volts depending on the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| -8191 | 0x2001 | -100% | -100 mV | -1 V |
| -4096 | 0x3000 | -50% | -50 mV | -.5 V |
| 0 | 0x0000 | 0% | 0 V | 0V |
| 4096 | 0x1000 | +50% | 50 mV | +.5 V |
| 8191 | 0x1FFF | +100% | +100 mV | +1 V |

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The following code fragment demonstrates how to convert a 2-byte sample value containing a signed 14-bit sample code to in volts.

```
double SampleToVoltsU14(U16 sampleValue, double inputRange_volts)
{
    // Right-shift 16-bit sample word by 2 to get 14-bit sample code
    int bitShift = 2;
    U16 sampleCode = sampeWord >> bitShift;

    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 14;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert the signed code to unsigned
    sampleCode = (sampleCode + 0x2000) & 0x1FFF;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

### 2.5.1.4 16-bit per sample

#### *2.5.1.4.1 Getting 2-byte sample values from the buffer*

The figure below displays the first 128-bytes of data in a buffer from a 16-bit digitizer such as the ATS660, ATS9462, ATS9625, or ATS9626.

**Figure 2-9 16-bit sample data**

```
000000  14 80 FB 7F FB 7F 08 80  FB 7F 00 80 02 80 ED 7F
000010  0B 80 FF 7F F8 7F 0B 80  09 80 0E 80 F3 7F FE 7F
000020  FF 7F E7 7F FA 7F 15 80  F8 7F EC 7F 0C 80 EF 7F
000030  EF 7F F1 7F F5 7F 06 80  FA 7F 02 80 E2 7F FC 7F
000040  17 80 FB 7F 04 80 0A 80  08 80 00 80 07 80 0B 80
000050  FF 7F 04 80 06 80 04 80  04 80 0B 80 F8 7F FC 7F
000060  F5 7F F7 7F 18 80 09 80  03 80 00 80 F8 7F 0A 80
000070  F2 7F F4 7F F3 7F F0 7F  FC 7F FA 7F 01 80 EF 7F
```

Each 16-bit sample value occupies 2 bytes in the buffer, so the figure displays 64 sample values (128 bytes / 2 bytes per sample).

The first 2 bytes in the buffer, shown highlighted, are 0x14 and 0x80. Two-byte samples values are stored in little-endian byte order in the buffer, so the first sample value is 0x8014.

The following code fragment demonstrates how to access each 16-bit sample value in a buffer.

```
U16 *pSamples = (U16*)buffer;
for (U32 sample = 0; sample < samplesPerBuffer; sample++)
```

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```
    {
        U16 sampleValue = * pSamples++;
        printf("sample value = %04X\n", sampleValue);
    }
```

#### *2.5.1.4.2 Getting 16-bit sample codes from 16-bit sample values*

A16-bit sample code is stored in each 16-bit sample value in the buffer. In the example above, the first sample code is 0x8014, or 32788 decimal.

#### *2.5.1.4.3 Converting unsigned 16-bit sample codes to volts*

An unsigned code of 32768 (0x8000) represents ~0V input voltage, 65535 (0xFFFF) represents a positive full-scale input voltage, and 0 represents a negative full-scale input voltage.

The following table illustrates how unsigned 16-bit sample codes map to values in volts according to the full-scale input range of an input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| 0 | 0x0000 | -100% | -100 mV | -1 V |
| 16384 | 0x4000 | -50% | -50 mV | -.5 V |
| 32768 | 0x8000 | 0% | 0 V | 0V |
| 49152 | 0xC000 | +50% | 50 mV | +.5 V |
| 65535 | 0xFFFF | +100% | +100 mV | +1 V |

The following code fragment demonstrates how to convert a 2-byte sample value containing an unsigned 16-bit sample code to in volts.

```
double SampleToVoltsU16(U16 sampleValue, double inputRange_volts)
{
    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 16;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleValue - codeZero) / codeRange);

    return sampleVolts;
}
```

#### *2.5.1.4.4 Converting signed 16-bit sample codes to volts*

A signed code of 32767 (0x7FFF) represents a positive full-scale input voltage, 0 represents ~0V input voltage, and –32768 (0x8000) represents a negative full-scale input voltage.

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The following table illustrates how signed 16-bit sample codes map to values in volts according to the full-scale input range of the input channel.

| Sample code in decimal | Sample code in hex | Sample value as a percentage of full-scale input range | Sample value in volts if full-scale input range is ±100 mV | Sample value in volts if full-scale input range is ±1 V |
|---|---|---|---|---|
| -32767 | 0x8001 | -100% | -100 mV | -1 V |
| -16384 | 0xC000 | -50% | -50 mV | -.5 V |
| 0 | 0x0000 | 0% | 0 V | 0V |
| 16384 | 0x4000 | +50% | 50 mV | +.5 V |
| 32767 | 0x7FFF | +100% | +100 mV | +1 V |

The following code fragment demonstrates how to convert a 2-byte sample word containing a signed 16-bit sample code to in volts.

```
double SampleToVoltsS16(U16 sampleValue, double inputRange_volts)
{
    // AlazarTech digitizers are calibrated as follows
    int bitsPerSample = 16;
    double codeZero = (1 << (bitsPerSample - 1)) - 0.5;
    double codeRange = (1 << (bitsPerSample - 1)) - 0.5;

    // Convert signed sample value to unsigned code
    U16 sampleCode = (sampleValue + 0x8000);

    // Convert sample code to volts
    double sampleVolts = inputRange_volts *
       ((double) (sampleCode - codeZero) / codeRange);

    return sampleVolts;
}
```

### 2.5.2 Saving binary files

If an application saves sample data to a binary data file for later processing, it may be possible to improve disk write speeds by considering the following recommendations.

#### 2.5.2.1 C/C++ applications

If the application is written in C/C++ and is running under Windows, use the Windows CreateFile API with the FILE_FLAG_NO_BUFFERING flag for file I/O, if possible. Sequential disk write speeds are often substantially higher when this option is selected.

See "%ATS_SDK_DIR%\Samples\DualPort\TS_DisableFileCache" for a sample program that demonstrates how to use this API to stream data to disk.

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#### 2.5.2.2 Visual Basic/LabVIEW applications

If the application is written in VisualBasic, LabVIEW, or another high-level programming environment, the consider using the AlazarCreateStreamFile API function. This function creates a binary data file, and enables the API to save each buffer received during an AutoDMA acquisition to this file.

The API uses high-performance disk I/O functions that would be difficult to implement in high-level environments like LabVIEW and Visual Basic. As a result, it allows an application in such an environment to perform high-performance disk streaming with a single additional function call.

The following code fragment outlines how to write a disk streaming application using AlazarCreateStreamFile:

```
// Allow the API to allocate and manage AutoDMA buffers

flags |= ADMA_ALLOC_BUFFERS;

// Configure the board to make an AutoDMA acquisition

AlazarBeforeAsyncRead(
    handle,                 // HANDLE -- board handle
    channelMask,            // U32 -- enabled channel mask
    -(long)preTriggerSamples,   // long -- trigger offset
    samplesPerRecord,       // U32 -- samples per record
    recordsPerBuffer,       // U32 -- records per buffer
    recordsPerAcquisition,  // U32 -- records per acquisition
    flags                   // U32 -- AutoDMA mode and options
    );

// Create a binary data file, and enable the API save each
// AutoDMA buffer to this file.

AlazarCreateStreamFile(handle, "data.bin");

// Arm the board to begin the acquisition

AlazarStartCapture(handle);

// Wait for each buffer in the acquisition to be filled

RETURN_CODE retCode = ApiSuccess;
while (retCode == ApiSuccess)
{
    // Wait for the board to receive sufficient trigger
    // events to fill an internal buffer.
    // The API will save the buffer to a binary data file,
    // but will not copy any data into our buffer.

    retCode =
        AlazarWaitNextAsyncBufferComplete(
            handle,         // HANDLE -- board handle
            NULL,           // void* -- buffer to receive data
            0,              // U32 -- bytes to copy into buffer
```

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```
                timeout_ms      // U32 -- time to wait for buffer
                );
    }

    // Abort the acquisition and release resources.
    // This function must be called after an acquisition.

    AlazarAbortAsyncRead(boardHandle);
```

See "%ATS_SDK_DIR%\Samples\DualPort\CS_CreateStreamFile" for a full sample program that demonstrates how to stream sample data to disk using AlazarCreateStreamFile.

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# 3 Reference

## 3.1 Function Groups

The ATS-SDK is organized into the following functional groups. See AlazarApi.h for function declarations.

### 3.1.1 Initialization

| Name | Purpose |
|---|---|
| AlazarBoardsFound | Get the number of boards detected in all board systems. |
| AlazarBoardsInSystemByHandle | Get the number of boards in the board system specified by the handle to its master board. |
| AlazarBoardsInSystemBySystemID | Get the number of boards in the board system specified by its system identifier. |
| AlazarClose | Close a board handle. |
| AlazarGetBoardBySystemHandle | Get a handle to a board specified by its board identifier and handle to the master board in its board system. |
| AlazarGetBoardBySystemID | Get a handle to a board specified by its system identifier and board identifier. |
| AlazarGetSystemHandle | Get a handle to the master board in a board system specified by its system identifier. |
| AlazarNumOfSystems | Get the number of board systems in a PC. |
| AlazarOEMDownLoadFPGA | Download an FPGA image file to a board. |
| AlazarOpen | Open a board handle. |
| AlazarParseFPGAName | Extract the attributes from an FPGA file name. |

### 3.1.2 Status and information

| Name | Purpose |
|---|---|
| AlazarErrorToText | Convert API error number to NULL terminated string. |
| AlazarGetBoardKind | Get a board's model from its handle. |
| AlazarGetBoardRevision | Get the PCB hadware revision level of a digitizer board |
| AlazarGetChannelInfo | Get the number of bits per sample, and on-board memory size in samples per channel. |
| AlazarGetCPLDVersion | Get the CPLD version of a board. |
| AlazarGetDriverVersion | Get the driver version of a board. |
| AlazarGetParameter | Get a board parameter as a signed 32-bit value. |
| AlazarGetParameterUL | Get a board parameter as an unsigned 32-bit value. |
| AlazarGetSDKVersion | Get the API version. |
| AlazarQueryCapability | Get a board capability as an unsigned 32-bit value. |

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### 3.1.3 Configuration and control

| Name | Purpose |
|---|---|
| AlazarConfigureAuxIO | Configure the AUX I/O connector of a board. |
| AlazarConfigureRecordAverage | Configure a digitizer to add a specified number of records in an accumulator record, and transfer accumulator records rather than ADC sample records. |
| AlazarConfigureSampleSkipping | Configure the digitizer to sub-sample records in arbitrary, non-uniform intervals. |
| AlazarCoprocessorDownload | Download an FPGA image to a coprocessor FPGA |
| AlazarCoprocessorRegisterRead | Read the contents of a coprocessor FPGA register |
| AlazarCoprocessorRegisterWrite | Write a value to coprocessor a coprocessor FPGA register |
| AlazarInputControl | Configure the range, coupling, and termination of an input channel. |
| AlazarResetTimeStamp | Control record timestamp counter resets. |
| AlazarSetBWLimit | Enable or disable the 20 MHz low-pass filter of an input channel of board. |
| AlazarSetCaptureClock | Configure the timebase of a board. |
| AlazarSetClockSwitchOver | Configure the dummy clock. |
| AlazarSetExternalClockLevel | Set the external clock comparator level of a board. |
| AlazarSetExternalTrigger | Configure the TRIG IN connector of a board. |
| AlazarSetLED | Control the LED on the PCI/PCIe mounting bracket of a board. |
| AlazarSetParameter | Set a board property as a signed 32-bit value. |
| AlazarSetParameterUL | Set a board property as an unsigned 32-bit value. |
| AlazarSetTriggerDelay | Specify the amount of time between the arrival of a trigger event, and the acquisition of the first sample of a record. |
| AlazarSetTriggerOperation | Configure the trigger system of a board. |
| AlazarSetTriggerOperationForScanning | Configure the trigger system of a board to use an external trigger input when it also uses an external clock signal that does not remain suitable for the board between trigger events. |
| AlazarSetTriggerTimeOut | Specify the amount of time to wait for a hardware trigger before automatically generating a software trigger event. |
| AlazarSleepDevice | Turn off the ADC converters. |

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## 3.1.4 Acquisition

### 3.1.4.1 General

| Name | Purpose |
|---|---|
| AlazarForceTrigger | Generate a software trigger event. |
| AlazarGetStatus | Return a bitmask with acquisition information |
| AlazarSetRecordSize | Specify the number of samples before and after the sample at the trigger position in a record. |
| AlazarStartCapture | Arm a board to wait for trigger events. |
| AlazarTriggered | Determine if a board has received at least one trigger event since the start of an acquisition. |
| AlazarAllocBufferU16 | Allocate a buffer for DMA transfers from a 16-bit digitizer. |
| AlazarAllocBufferU8 | Allocate a buffer for DMA transfers from an 8-bit digitizer. |
| AlazarFreeBufferU16 | Free a buffer allocated by AlazarAllocBufferU16 |
| AlazarFreeBufferU8 | Free a buffer allocated by AlazarAllocBufferU8 |

### 3.1.4.2 Single-port acquisitions

| Name | Purpose |
|---|---|
| AlazarAbortCapture | Abort a single-ported acquisition to on-board memory. |
| AlazarBusy | Determine if an acquisition to on-board memory is in progress. |
| AlazarGetMaxRecordsCapable | Find the maximum number of records that can be captured to on-board memory given a number of samples per record |
| AlazarGetTriggerAddress | Get the trigger address and timestamp of a record acquired to on-board memory. |
| AlazarGetTriggerTimestamp | Retrieve the trigger timestamp of a record acquired to on-board memory. |
| AlazarGetWhoTriggeredBySystemHandle | Get the event that caused a board system, specified by the handle to its master board, to trigger. |
| AlazarGetWhoTriggeredBySystemID | Get the event that caused a board system, specified by its system identifier, to trigger. |
| AlazarHyperDisp | Enable the on-board FPGA to divide a record acquired to on-board memory into intervals, and return the minimum and maximum sample values over each interval. |
| AlazarRead | Transfer all or part of a record acquired to on-board memory. |
| AlazarReadEx | Transfer all or part of a record acquired to on-board memory when the record has 2,147,483,648 or more samples. |
| AlazarSetRecordCount | Specify the number of records to capture to |

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| | |
|---|---|
| | on-board memory. |

### 3.1.4.3 Dual-port Asynchronous AutoDMA acquisitions

| Name | Purpose |
|---|---|
| AlazarAbortAsyncRead | Abort an asynchronous AutoDMA acquisition, and release any resources allocated during the acquisition. |
| AlazarAsyncRead | Add a buffer to the end of a list of buffers available to be filled by a board. |
| AlazarBeforeAsyncRead | Configure a board to make an asynchronous AutoDMA acquisition. |
| AlazarCreateStreamFile | Create a binary data file to store sample data for a board. |
| AlazarForceTriggerEnable | Generate a software trigger enable event. |
| AlazarPostAsyncBuffer | Add a buffer to the end of a list of buffers available to be filled by a board. |
| AlazarWaitAsyncBufferComplete | Wait a specified amount of time for a board to receive sufficient trigger events to fill the specified AutoDMA buffer. |
| AlazarWaitNextAsyncBufferComplete | Wait a specified amount of time for a board to receive sufficient trigger events to fill an AutoDMA buffer managed by the API. |

### 3.1.4.4 Dual-port Synchronous AutoDMA acquisitions

| Name | Purpose |
|---|---|
| AlazarAbortAutoDma | Abort synchronous AutoDMA acquisition |
| AlazarCloseAUTODma | Release any resources allocated during a synchronous AutoDMA acquisition. |
| AlazarEvents | Enable a board to wait for the end of an AutoDMA transfer. |
| AlazarForceTriggerEnable | Generate a software trigger enable event. |
| AlazarFlushAutoDMA | Stop a synchronous AutoDMA acquisition. |
| AlazarGetAutoDMAHeaderTimeStamp | Get a record timestamp from an AutoDMA buffer. |
| AlazarGetAutoDMAHeaderValue | Get an attribute from the record header of an AutoDMA buffer. |
| AlazarGetAutoDMAPtr | Get a pointer to the header or data portions of a record in an AutoDMA buffer. |
| AlazarGetNextAutoDMABuffer | Poll for an AutoDMA transfer to complete. |
| AlazarGetNextBuffer | Poll for an AutoDMA transfer to complete. |
| AlazarStartAutoDMA | Configure a board to make a synchronous AutoDMA acquisition. |
| AlazarStopAutoDMA | Inhibit the software from issuing any new DMA request to the board. |

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| | |
|---|---|
| AlazarWaitForBufferReady | Wait for an AutoDMA transfer to complete. |

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## 3.2 Function Reference

This section provides an alphabetical list of the functions exported by the ATS-SDK, and their descriptions.

### 3.2.1 AlazarAbortAsyncRead

Aborts any in-progress DMA transfers, and cancel any pending transfers.

**Syntax**

```
C/C++
RETURN_CODE
AlazarAbortAsyncRead (
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarAbortAsyncRead (
      ByVal BoardHandle As Integer
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails because it was unable to abort an in-progress DMA transfer, it returns ApiDmaInProgress (518).

If **AlazarAbortAsyncRead** fails under Windows because the Windows CancelIo system call failed, the function returns ApiFailed (513). Call the Windows GetLastError API for more information.

If the function fails for some other reason, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

If you have called AlazarAsyncRead or AlazarPostAsyncBuffer, and there are buffers pending, you *must* call **AlazarAbortAsyncRead** before your application exits.

If you do not, when you program exits Microsoft Windows may stop with a blue screen error number 0x000000CB (DRIVER_LEFT_LOCKED_PAGES_IN_PROCESS). Linux may leak the memory used by the DMA buffers.

**See Also**

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AlazarAsyncRead
AlazarPostAsyncBuffer
Using asynchronous AutoDMA

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### 3.2.2 AlazarAbortAutoDma

**This function is deprecated. Do not use in new designs.**

This routine is used to terminate the AutoDMA capture in cases where the trigger system stopped generating triggers before the buffer was filled by the AutoDMA engine. The routine will populate the buffer with the appropriate number of records that have been successfully captured.

**Syntax**

```
C/C++
RETURN_CODE
AlazarAbortAutoDMA(
      HANDLE h,
      void* Buffer,
      AUTODMA_STATUS* error,
      U32 r1,
      U32 r2,
      U32 *r3,
      U32 *r4
);
```

```
VisualBasic
AlazarAbortAutoDMA( _
      ByVal h As Integer, _
      ByRef Buffer1 As Any, _
      ByRef error As Long, _
      ByVal r1 As Long, _
      ByVal r2 As Long, _
      ByRef r3 As Long, _
      ByRef r4 As Long _
) As Long
```

**Parameters**

*h*

[in] Board identification handle.

*Buffer*

[out] This Buffer is used to transfer a set of Records from the Device back to the user application.

*Error*

[out] Error return code.

This error code may be one of the following values.

| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |

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| | | |
|---|---|---|
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

*r1*

[in] RESERVED.

*r2*

[in] RESERVED.

*r3*

[out] RESERVED.

*r4*

[out] RESERVED.

**Return values**

See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarStartAutoDMA
AlazarCloseAUTODma
Using synchronous AutoDMA

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### 3.2.3 AlazarAbortCapture

Abort an acquisition to on-board memory.

**Syntax**

```
C/C++
RETURN_CODE
AlazarAbortCapture (
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarAbortCapture ( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

None

**See Also**

AlazarRead
AlazarHyperDisp
Acquiring to on-board memory

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### 3.2.4 AlazarAllocBufferU16

Allocate a buffer for DMA transfers from a 16-bit digitizer.

**Syntax**

```
C/C++
U16*
AlazarAllocBufferU16 (
      HANDLE BoardHandle,
      U32    SampleCount
);
```

```
VisualBasic
AlazarAllocBufferU16 ( _
      ByVal BoardHandle As Long _
      ByVal SampleCount As Long_
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*SampleCount*
[in] Buffer size in samples.

**Return value**

If it succees, this function returns the base address of a page aligned region in the virtual address space of the calling process.

If it fails, this functions returns NULL.

**Remarks**

This function returns a buffer whose base address meets the alignment requirement for single- or dual-port DMA transfers of all 16-bit digitizers.

The buffer should be freed by calling AlazarFreeBufferU16.

**See Also**

AlazarAllocBufferU8
AlazarFreeBufferU16
AlazarFreeBufferU8

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### 3.2.5 AlazarAllocBufferU8

Allocate buffer for DMA transfers from an 8-bit digitizer.

**Syntax**

```
C/C++
U8*
AlazarAllocBufferU8 (
      HANDLE BoardHandle,
      U32    SampleCount
);
```

```
VisualBasic
AlazarAllocBufferU8 ( _
      ByVal BoardHandle As Long _
      ByVal SampleCount As Long_
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*SampleCount*
[in] Buffer size in samples.

**Return value**

If it succees, this function returns the base address of a page aligned region in the virtual address space of the calling process.

If it fails, this functions returns NULL.

**Remarks**

This function returns a buffer whose base address meets alignment requirements for DMA transfers in single- or dual-port mode from all 8-bit digitizers.

The buffer must be freed by calling AlazarFreeBufferU8.

**See Also**

AlazarAllocBufferU16
AlazarFreeBufferU16
AlazarFreeBufferU8

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### 3.2.6 AlazarAsyncRead

Add a buffer to the end of a list of buffers available to be filled by the board. When the board receives sufficient trigger events to fill the buffer, the event in the OVERLAPPED will be set to the signaled state.

**Syntax**

```
C/C++
RETURN_CODE
AlazarAsyncRead(
      HANDLE BoardHandle,
      void *Buffer,
      U32 BytesToRead,
      OVERLAPPED *Overlapped
);
```

```
VisualBasic
Not available
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Buffer*

[out] Pointer to a buffer to receive sample data from the digitizer board.

*BytesToRead*

[in] Specifies the number of bytes to read from the board.

*Overlapped*

[in] Pointer to an OVERLAPPED structure.

The event in the OVERLAPPED structure is set to the signaled state when the read operation completes.

**Return value**

If the function succeeds in adding the buffer to end of the list of buffers available to be filled by the board, it returns ApiDmaPending (585). When the board fills the buffer, the event in the OVERLAPPED structure is to the signaled state.

If the function fails because the board overflowed its on-board memory, it returns ApiBufferOverflow (582). The board may overflow its on-board memory because the rate at which it is acquiring data is faster than the rate at which it is transferring data from on-board memory to host memory. If this is the case, try reducing the sample rate, number of enabled channels, or amount of time spent processing each buffer.

If the function fails because the buffer is too large for the driver or operating system to prepare for scatter-gather DMA transfer, it returns ApiLockAndProbePagesFailed (586).

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Try reducing the size of each buffer, or reducing the number of buffers queued by the application.

If the function fails for some other reason, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**AlazarAsyncRead** is only available under Windows.

You must call AlazarBeforeAsyncRead before calling **AlazarAsyncRead**.

You must call AlazarAbortAsyncRead before your application exits if you have called **AlazarAsyncRead**, and buffers are pending when you wish to exit your application.

The BytesToRead parameter must be equal to the product of the number of bytes per record, the number of records per buffer, and the number of enabled channels. If record headers are enabled, the number of bytes per record must include the size of the record header (16 bytes).

**See Also**

AlazarAbortAsyncRead
AlazarBeforeAsyncRead
Using asynchronous AutoDMA

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### 3.2.7 AlazarBeforeAsyncRead

Configure a board to make an asynchronous AutoDMA acquisition.

**Syntax**

```
C/C++
RETURN_CODE
AlazarBeforeAsyncRead(
   HANDLE BoardHandle,
   U32 ChannelSelect,
   long TransferOffset,
   U32 SamplesPerRecord,
   U32 RecordsPerBuffer,
   U32 RecordsPerAcquisition,
   U32 Flags
);
```

```
VisualBasic
AlazarBeforeAsyncRead( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelSelect As Long, _
      ByVal TransferOffset As Long, _
      ByVal SamplesPerRecord As Long, _
      ByVal RecordsPerBuffer As Long, _
      ByVal RecordsPerAcquisition As Long, _
      ByVal Flags As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*ChannelSelect*

[in] Select the channel to control.

This parameter may be one of the following identifiers or values.

| Identifier | Value | Meaning |
|---|---|---|
| CHANNEL_A | 1 | Acquire from CH A only |
| CHANNEL_B | 2 | Acquire from CH B only |
| CHANNEL_A \| CHANNEL_B | 3 | Acquire from both CH A and B. |

On digitizer with 4 analog input channels, this parameter may also be one of the following identifiers or values:

| Identifier | Value | Meaning |
|---|---|---|
| CHANNEL_C | 4 | CH C only |
| CHANNEL_A \| CHANNEL_C | 5 | CH A and CH C |
| CHANNEL_B \| CHANNEL_C | 6 | CH B and CH C |
| CHANNEL_D | 8 | CH D only |

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| | | |
|---|---|---|
| CHANNEL_A \| CHANNEL_D | 9 | CH A and CH D |
| CHANNEL_B \| CHANNEL_D | 10 | CHB and CHD |
| CHANNEL_C \| CHANNEL_D | 12 | CHC and CHD |
| CHANNEL_A \| CHANNEL_B \| CHANNEL_C \| CHANNEL_D | 15 | CHA, CHB, CHC, and CHD |

*TransferOffset*

[in] Specify the first sample from each on-board record to transfer from on-board to host memory. This value is a sample relative to the trigger position in an on-board record.

*SamplesPerRecord*

[in] Specify the number of samples from each record to transfer from on-board to host memory. See remarks below.

*RecordsPerBuffer*

[in] Specify the number of records in each buffer. See remarks below.

*RecordsPerAcquisition*

[in] Specify the number of records in to acquire during acquisition. Set to 0x7fffffff to acquire indefinitely until the acquisition is aborted. See remarks below.

*Flags*

[in] Specify AutoDMA mode and options.

AutoDMA mode must be one of the following values.

| Identifier | Meaning |
|---|---|
| ADMA_TRADITIONAL_MODE (0x00000000) | Acquire multiple records: one per trigger event. Each record may include pre-and post-trigger samples, and a record header that includes its trigger timestamp.<br><br>If a board has on-board memory and sample interleave is not enabled, each buffer will contain samples organized as follows: R1A, R1B, R2A, R2B …<br><br>If a board does not have on-board memory, or sample interleave is enabled, the buffer will contain samples organized as follows: R1[AB…], R2[AB…] … |
| ADMA_NPT (0x00000200) | Acquire multiple records: one per trigger event. Each record contains only post-trigger samples.<br><br>If a board has on-board memory and sample interleave is not enabled, each buffer will contain samples organized as |

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| | |
|---|---|
| | follows: R1A, R2A, … R1B, R2B …<br><br>If a board does not have on-board memory, or sample interleave is enabled, the buffer will contain samples organized as follows: R1[AB…], R2[AB…] … |
| ADMA_CONTINUOUS_MODE (0x00000100) | Acquire a single, gapless record spanning multiple buffers. Do not wait for trigger event before starting the acquisition.<br><br>If a board has on-board memory and sample interleave is not enabled, each buffer will contain samples organized as follows: R1A, R1B.<br><br>If a board does not have on-board memory, or sample interleave is enabled, the buffer will contain samples organized as follows: R1[AB…] |
| ADMA_TRIGGERED_STREAMING (0x00000400) | Acquire a single, gapless record spanning multiple buffers. Wait for a trigger event before starting the acquisition.<br><br>If a board has on-board memory and sample interleave is not enabled, each buffer will contain samples organized as follows: R1A, R1B.<br><br>If a board does not have on-board memory, or sample interleave is enabled, the buffer will contain samples organized as follows: R1[AB…] |

AutoDMA options may be a combination of one or more of the following values.

| Identifier | Meaning |
|---|---|
| ADMA_EXTERNAL_STARTCAPTURE (0x00000001) | If this flag is set, the acquisition will start when the application calls AlazarStartCaputre.<br><br>If this flag is not set, the acquisition will start before **AlazarBeforeAsyncRead** returns. |
| ADMA_ENABLE_RECORD_HEADERS (0x00000008) | If this flag is set, precede each record in each buffer with a 16-byte header |

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| | |
|---|---|
| | that includes the record's trigger timestamp.<br><br>Note that this flag can only be used in "traditional" AutoDMA mode. Record headers are not available in NPT, streaming, or triggered streaming modes. |
| ADMA_ALLOC_BUFFERS (0x00000020) | If this flag is set, the API will allocate and manage a list of DMA buffers.<br><br>This flag may be used by LabVIEW, and in other high-level development environments, where it may be more convenient for the application to let the API manage a list of DMA buffers, and to receive a copy of data in an application buffer.<br><br>When this flag is set, the application must call AlazarWaitNextAsyncBufferComplete to wait for a buffer to complete and receive a copy of the data.<br><br>The application can specify the number of DMA buffers for the API to allocate by calling AlazarSetParameter with the parameter SETGET_ASYNC_BUFFCOUNT before calling **AlazarBeforeAsyncRead**. |
| ADMA_FIFO_ONLY_STREAMING (0x00000800) | Enable the board to data from its on-FPGA FIFO rather than from on-board memory.<br><br>When the flag is set, each buffer contains data organized as follows: R0[ABAB…], R1[ABAB…], R2[ABAB] …. That is, each sample from CH A is followed by a sample from CH B.<br><br>When this flag is not set, each record in a buffer contains a contiguous array of samples for CH A followed by a |

| | |
|---|---|
| | contiguous array of samples for CH B, where the record arrangement depends on the acquisition mode.<br><br>Note that this flag must be set if your board does not have on-board memory. For example, an ATS9462-FIFO requires this flag.<br><br>Also note that this flag must not be set if your board has on-board memory. |
| ADMA_INTERLEAVE_SAMPLES (0x00001000) | Enable a board to interleave samples from both digitizer channels in dual-channel acquisition mode. This results in higher data transfer rates on boards that support this option.<br><br>Note that this flag has no effect in single channel mode, and is supported by only PCIe digitizers (except the ATS9462).<br><br>When the flag is set, each buffer contains data organized as follows: R0[ABAB…], R1[ABAB…], R2[ABAB] …. That is, each sample from CH A is followed by a sample from CH B.<br><br>When this flag is not set, each record in a buffer contains a contiguous array of samples for CH A followed by a contiguous array of samples for CH B, where the record arrangement depends on the acquisition mode. |
| ADMA_GET_PROCESSED_DATA (0x00002000) | Enable the API to process each buffer so that the sample data in a buffer is always arranged as in NPT mode: R0A, R1A, R2A, … RB0, R1B, R2B.<br><br>If this flag is not set, the data arrangement in a buffer depends on the acquisition mode.<br><br>LabVIEW and other higher-level applications may use this flag to |

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| | |
|---|---|
| | simplify data processing since all data buffers will have the same arrangement independent of the acquisition mode.<br><br>Note that the ADMA_ALLOC_BUFFERS flag must also be set to use this option. |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The **SamplesPerRecord** parameter must be a multiple of 16.

The **RecordsPerBuffer** parameter must be set to 1 in continuous streaming, and triggered streaming AutoDMA modes.

The **RecordsPerAcquisition** parameter must be either:
- An multiple of the **RecordsPerBuffer** parameter, or
- 0x7FFFFFFF to indicate that the acquisition should continue indefinitely until aborted.

When record headers are not enabled, the total number of bytes per AutoDMA buffer is given by:

```
BytesPerBuffer = BytesPerSample * SamplesPerRecord *
                 RecordsPerBuffer;
```

When record headers are enabled, the total number bytes per AutoDMA buffer is given by:

```
// Each record header occupies 16-bytes
BytesPerBuffer = (16 + BytesPerSample * SamplesPerRecord) *
                 RecordsPerBuffer;
```

For best performance, AutoDMA parameters should be selected so that the total number of bytes per buffer is greater than about 1MB. This allows for relatively long DMA transfers times compared to the time required to prepare a buffer for a DMA transfer, and to re-arm a DMA engine.

ATS460, ATS660, and ATS860 digitizer boards require that AutoDMA parameters be selected so that the total number of bytes per buffer is less than 4MB.

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**See Also**

AlazarAsyncRead
AlazarAbortAsyncRead
AlazarPostAsyncBuffer
AlazarWaitAsyncBufferComplete
AlazarWaitNextAsyncBufferComplete
Using asynchronous AutoDMA

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### 3.2.8 AlazarAutoCalibrate

Perform a board specific calibration.

**Syntax**

```
C/C++
RETURN_CODE
AlazarAutoCalibrate(
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarAutoCalibrate( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that should indicate the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

This function is not implemented.

**See Also**

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### 3.2.9 AlazarBoardsFound

Determine the number of digitizer boards that were detected in all board systems.

**Syntax**

```
C/C++
U32 AlazarBoardsFound ();
```

```
VisualBasic
AlazarBoardsFound() As Integer
```

**Parameters**

None

**Return value**

The total number of digitizer boards detected.

**Remarks**

None

**See Also**

AlazarNumOfSystems

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### 3.2.10 AlazarBoardsInSystemByHandle

Return the number of digitizer boards in a board system specified by the handle of its master board.

**Syntax**

```
C/C++
U32 AlazarBoardsInSystemByHandle (
      HANDLE BoardHandle
);
```

```
VisualBasic
AlazarBoardsFound( _
      ByVal BoardHandle As Integer _
) As Integer
```

**Parameters**

*BoardHandle*
[in] Handle to master board.

**Return value**

The number of boards in the specified board system.

**Remarks**

If this function is called with the handle to the master board is a master-slave system, it returns the total number of boards in the system, including the master.

If this function is called with the handle an independent board, it returns 1.

If this function is called with the handle to a slave board in a master-slave system, or with an invalid handle, it returns 0.

**See Also**

AlazarBoardsInSystemBySystemID
AlazarGetSystemHandle

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### 3.2.11 AlazarBoardsInSystemBySystemID

Return the number of digitizer boards in a board system specified its system ID.

**Syntax**

```
C/C++
U32 AlazarBoardsInSystemBySystemID(
      U32 SystemId
);
```

```
VisualBasic
AlazarBoardsInSystemBySystemID( _
      ByVal SystemId As Integer _
) As Integer
```

**Parameters**

*SystemId*
[in] Board system identifier.

**Return value**

The number of boards in the specified system.

**Remarks**

If this function is called with the identifier of a master-slave system, it returns the total number of boards in the system, including the master.

If this function is called with identifier of an independent board system, it returns 1.

If this function is called with the identifier of an invalid board system, it returns 0.

**See Also**

AlazarBoardsInSystemByHandle
AlazarGetSystemHandle

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### 3.2.12 AlazarBusy

Determine if an acquisition to on-board memory is in progress.

**Syntax**

```
C/C++
U32 AlazarBusy (
      HANDLE BoardHandle
);
```

```
VisualBasic
AlazarBusy ( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the board is busy acquiring to on-board memory, this function returns 1.

Otherwise, this function returns 0.

**Remarks**

This function is part of the single-port acquisition API. Once an acquisition to on-board memory is finished, use the AlazarRead, AlazarReadEx, or AlazarHyperDisp functions to transfer sample data from on-board to host memory.

**See Also**

AlazarHyperDisp
AlazarRead
AlazarReadEx
AlazarStartCapture

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### 3.2.13 AlazarClose

**This function is obsolete. Do not use in new designs.**

Close a board handle.

**Syntax**

```
C/C++
void AlazarClose (
      HANDLE BoardHandle
);
```

```
VisualBasic
AlazarClose (
      ByVal BoardHandle As Integer
)
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the board is acquiring to on-board memory, this function returns 1. Otherwise, this function returns 0.

**Remarks**

The API manages board handles internally. This function should only be used in applications that are written for single board digitizer systems.

**See Also**

AlazarOpen

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### 3.2.14 AlazarCloseAUTODma

**This function is deprecated. Do not use in new designs.**

This routine will close the AUTODMA capabilities of the device. Only call this upon exit or error.

**Syntax**

```
C/C++
RETURN_CODE
AlazarCloseAUTODma(
      HANDLE h,
);
```

```
VisualBasic
AlazarCloseAUTODma( _
      ByVal h As Integer _
) As Long
```

**Parameters**

*h*

[in] Board identification handle.

**Return values**

See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarAbortAutoDma
Using synchronous AutoDMA

### 3.2.15 AlazarConfigureAuxIO

Configure the AUX I/O connector as an input or output signal.

**Syntax**

```
C/C++
RETURN_CODE
AlazarConfigureAuxIO(
      HANDLE BoardHandle,
      U32 Mode,
      U32 Parameter
);
```

```
VisualBasic
AlazarConfigureAuxIO( _
      ByVal BoardHandle As Integer, _
      ByVal Mode As Long, _
      ByVal Parameter As Long, _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Mode*

[in] Specify AUX I/O mode.

The mode may be one of the following values. See AlazarApi.h for a complete list of list of identifiers.

| Identifier | Value | Description |
|---|---|---|
| AUX_OUT_TRIGGER | 0 | Output a trigger signal synchronized with the sample clock. |
| AUX_IN_TRIGGER_ENABLE | 1 | Use the edge of a pulse to the AUX I/O connector as an AutoDMA trigger enable signal. |
| AUX_OUT_PACER | 2 | Output sample clock divided by user-defined value. |
| AUX_IN_AUXILIARY | 13 | Configure the AUX connector as a digital input. Call AlazarGetParameter(handle, 0, GET_AUX_INPUT_LEVEL, &level) to read the digital input level. |
| AUX_OUT_SERIAL_DATA | 14 | Use the AUX I/O connector as a general purpose digital output. |

If an AUX I/O output mode is selected, then the parameter may be OR'ed with AUX_OUT_TRIGGER_ENABLE (16) to enable the board to use software

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trigger enable. When this flag is set, the board will: wait for software to call AlazarForceTriggerEnable to generate a trigger enable event; then wait for sufficient trigger events to capture the records in an AutoDMA buffer; then wait for the next trigger enable event and repeat.

For example, the mode "AUX_OUT_TRIGGER_ENABLE | AUX_OUT_TRIGGER" enables trigger enable, and configures the AUX I/O connector as a trigger output, while "AUX_OUT_TRIGGER_ENABLE | AUX_OUT_PACER" enables trigger enable, and configures the AUX I/O connector as a pacer output.

*Parameter*

[in] Parameter value.

The meaning of the parameter value depends on the AUX I/O mode.

| Mode | Parameter value |
|---|---|
| AUX_OUT_TRIGGER | The value is ignored |
| AUX_IN_TRIGGER_ENABLE | The value specifies slope of TTL trigger enable signal:<br>• TRIGGER_SLOPE_POSITIVE (1)<br>The trigger enable signal is the rising edge of a TTL pulse to the AUX I/O connector.<br>• TRIGGER_SLOPE_NEGATIVE (2)<br>The trigger enable signal is the falling edge of a TTL pulse to the AUX I/O connector. |
| AUX_OUT_PACER | The value specifies sample clock divider. Note that the divider must be greater than 2. |
| AUX_OUT_SERIAL_DATA | The value specifies the TTL output level:<br>• 0 = TTL low-level<br>• 1 = TTL high level |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The AUX I/O connector generates TTL level signals when configured as an output, and expects TTL level signals when configured as an input.

AUX I/O output signals may be limited by the bandwidth of the AUX output drivers.

The ATS9440 has two AUX I/O connectors: AUX I/O 1 and AUX I/O 2. AUX I/O 1 is configured by firmware as a trigger output signal, while AUX I/O 2 is configured by software using AlazarConfigureAuxIO. A firmware update is required to change the operation of AUX I/O 1.

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The ATS9625 and ATS9626 have to AUX I/O connectors: AUX 1 and AUX 2. AUX 1 is configured by software using AlazarConfigureAuxIO, while AUX 2 is configured by default as a trigger output signal. A custom user-programmable FPGA can control the operation of AUX 2 as required by the FPGA designer.

**See Also**

### 3.2.16 AlazarConfigureRecordAverage

This function configures a digitizer to co-add ADC samples from a specified number of records in an accumulator record, and transfer accumulator records rather than the ADC sample values.

Syntax

```
C/C++
RETURN_CODE
AlazarConfigureRecordAverage(
      HANDLE BoardHandle,
      U32    Mode,
      U32    SamplesPerRecord,
      U32    RecordsPerAverage,
      U32    Options
);
```

```
VisualBasic
AlazarConfigureRecordAverage( _
      ByVal BoardHandle As Long, _
      ByVal Mode As Long, _
      ByVal SamplesPerRecord As Long, _
      ByVal RecordsPerAverage As Long, _
      ByVal Options As Long, _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Mode*

[in] Select averaging mode.

The parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| CRA_MODE_DISABLE | 0 | Disable record averaging. |
| CRA_MODE_ENABLE_FPGA_AVE | 1 | Enable FPGA record averaging. |

*SamplePerRecord*

[in] Specifiy the number ADC samples per accumulator record.

*RecordsPerAverage*

[in] Specify the number of records to accumulate per average.

*Mode*

[in] Select averaging options.

The parameter may be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| CRA_OPTION_UNSIGNED | 0 | Find the sum of unsigned ADC samples |

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| | | |
|---|---|---|
| | | codes. |
| CRA_OPTION_SIGNED | 1 | Find the sum of signed ADC sample codes. |

**Return value**

If the function succeeds, it returns ApiSuccess (512). If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

FPGA record averaging is currently supported on the following digitizers:

| Model | FPGA version | Driver version |
|---|---|---|
| ATS9870 | 180.0 | 5.9.8 |

When FPGA record averaging is enabled, the digitizer transfers one accumulator record to host memory after "records per average" trigger events have been captured.

Each accumulator record has interleaved samples from CH and CH B:

A1, B1, A2, B2 … An, Bn, where n = "samples per record".

FPGA accmulators are 32-bits wide, so each accumulator value occupies 4-bytes in a buffer. The digitizer transfers multi-byte values in "little endian" byte order.

CH A and CB B accumulator record samples are always transferred to host memory. As a result, the number of bytes per accumulator record is: (samples per record per channel) * (2 channels) * (4 bytes per accumulator sample).

The maximum "records per average" for 8-bit digitizer is $2^{24} - 1 = 16{,}777{,}215$.

Note that "records per average" does not have to be equal to "records per buffer" in AutoDMA mode. The maximum "records per average" is 16,777,215 for 8-bit digitizers, while the maximum "records per buffer" is 8191.

**See Also**

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### 3.2.17 AlazarConfigureSampleSkipping

Use this function to allow the digitizer to sub-sample post trigger data in arbitrary, non-uniform intervals. The application specifies which sample clock edges after a trigger event that the digitizer should use to generate sample points, and which sample clock edges that the digitizer should ignore.

**Syntax**

```
C/C++
RETURN_CODE
AlazarConfigureSampleSkipping(
      HANDLE BoardHandle,
      U32 Mode,
      U32 SampleClocksPerRecord,
      U16 *pSampleSkipBitmap
);
```

```
VisualBasic
AlazarConfigureSampleSkipping( _
      ByVal BoardHandle As Long, _
      ByVal SamplesClocksPerRecord As Long, _
      ByRef pSampleSkipBitmap As Integer _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Mode*

[in] Select the data skipping mode.

The mode may be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| SSM_DISABLE | 0 | Disable sample skipping. |
| SSM_ENABLE | 1 | Enable sample skipping. |

*SampleClocksPerRecord*

[in] Specifiy the number of sample clocks per record.

*pSampleSkipBitmap*

[in] An array of bits that specifies which sample clocks edges should be used to capture a sample point (value = 1), and which sample clock edges should be ignored (bit value = 0).

**Return value**

If the function succeeds, it returns ApiSuccess (512). If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

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**Remarks**

To enable data skipping, first create a bitmap in memonry that specifies which sample clock edges should generate a sample point, and which sample clock edges should be ingored.

- 1's in the bitmap specify the clock edges that should generate a sample point.
- The total number of 1's in the bitmap must be equal to the number of post-trigger samples per record specified in the call to AlazarSetRecordSize.
- 0's in the bitmap specify the clock edges that should not be used to generate a sample point.
- The total total number of bits in the bitmap is equal to the number of sample clocks in one record.

For example, to receive 16 samples from 32 sample clocks where every other sample clock is ignored, create a bitmap of 32 bits with values { 1 0 1 0 1 0 … 1 0 }, or { 0x5555, 0x5555 }. Note that 16 of the 32 bits are 1's.

And to receive 24 samples from 96 sample clocks where data from every 3 of 4 samples clocks is ignored, create a bitmap of 96 bits with values { 1 0 0 0 1 0 0 0 1 0 0 0 … 1 0 0 0 }, or in { 0x1111, 0x1111, 0x1111, 0x1111, 0x1111, 0x1111 }. Note that 24 of the 96 bits are 1's.

After creating a bitmap, call **AlazarConfigureSampleSkipping** with:
- *Mode* equal to SSM_ENABLE (1).
- *SampleClocksPerRecord* equal to the total number of sample clocks per record.
- *pSampleSkipBitmap* with the address of the U16 array.

To disable data skipping, call **AlazarConfigureSampleSkipping** with Mode equal to SSM_DISABLE (0). The *SampleClocksPerRecord* and *pSampleSkipBitmap* parameters are ignored.

Note that data skipping currently is supported by the ATS9440 with FPGA version 3.1 or later, and only works with post-trigger data data acquired at 125 MSPS or 100 MSPS.

**See Also**

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### 3.2.18 AlazarCoprocessorDownload

Download an FPGA image in RBF (raw binary file) format to the coprocessor FPGA.

**Syntax**

```
C/C++
RETURN_CODE
AlazarCoprocessorDownloadA (
      HANDLE BoardHandle,
      char*  FileName
      U32    Options
);

RETURN_CODE
AlazarCoprocessorDownloadW (
      HANDLE BoardHandle,
      WCHAR* FileName
      U32    Options
);
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*char*, WCHAR**
[in] Path to RBF file.

*Options*
[in] Download options.

| Identifier | Meaning |
|---|---|
| CPF_OPTION_DMA_DOWNLOAD 0x00000001 | Use DMA to transfer the file contents to the coprocessor FPGA. |

**Return value**

The function returns ApiSuccess (512) if the function succeeds. Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The coprocessor FPGA file must be in RBF (raw binary file) format.

Use AlazarCoprocessorDownloadA to download files with ASCII file paths, and AlazarCoprocessorDownloadW to download files with UNICODE file paths.

Use the CPF_OPTION_DMA_DOWNLOAD option to minimize coprocessor FPGA download times.

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**See Also**

AlazarCoprocessorRegisterRead
AlazarCoprocessorRegisterWrite

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### 3.2.19 AlazarCoprocessorRegisterRead

Read the contents of a user-programmable coprocessor FPGA register.

**Syntax**

```
C/C++
RETURN_CODE
AlazarCoprocessorRegisterRead (
      HANDLE BoardHandle,
      U32 Offset
      U32 *pValue
);
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*Offset*
[in] Register offset.

*pValue*
[out] Adddress of variable to receive register value.

**Return value**

The function returns ApiSuccess (512) if the function succeeds. Otherwise, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

None

**See Also**

AlazarCoprocessorRegisterWrite
AlazarCoprocessorDownload

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### 3.2.20 AlazarCoprocessorRegisterWrite

Write a value to a user-programmable coprocessor FPGA register.

**Syntax**

```
C/C++
RETURN_CODE
AlazarCoprocessorRegisterWrite (
      HANDLE BoardHandle,
      U32 Offset
      U32 Value
);
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*Offset*
[in] Register offset.

*Value*
[in] Value to write.

**Return value**

The function returns ApiSuccess (512) if it was able to write to the specified coprocessor FPGA register.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

None

**See Also**

AlazarCoprocessorRegisterRead
AlazarCoprocessorDownload

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### 3.2.21 AlazarCreateStreamFile

Create a binary data file for this board, and enable saving AutoDMA data from this board to disk.

**Syntax**

```
C/C++
RETURN_CODE
AlazarCreateStreamFileA(
   HANDLE  BoardHandle,
   char *FilePath
   );

RETURN_CODE
AlazarCreateStreamFileW(
   HANDLE  BoardHandle,
   WCHAR* FilePath
   );
```

```
VisualBasic
AlazarCreateStreamFileA( _
      ByVal BoardHandle As Integer, _
      ByRef FileName As Any _
) As Integer
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*FilePath*

[in] Pointer to a NULL terminated string that specifies the name of the file.

**Return values**

If this function succeeds, it returns ApiSuccess (512).

If this function fails, it returns ApiFailed (513). Call the Windows GetLastError API for more information.

**Remarks**

**AlazarCreateStreamFileA** accepts 8-bit ACSII or MBCS paths, and **AlazarCreateStreamFileW** accepts 16-bit UNICODE paths.

C/C++ applications may use **AlazarCreateStreamFile**. It is defined in AlazarApi.h as follows:

```
#ifdef UNICODE
#define AlazarCreateStreamFile AlazarCreateStreamFileW
#else
```

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```
#define AlazarCreateStreamFile AlazarCreateStreamFileA
```

If possible, select AlazarBeforeAsyncRead parameters that result in DMA buffers whose length in bytes is evenly divisible into sectors on the volume specified by FilePath. If the DMA buffer length is evenly divisible into sectors, **AlazarCreateStreamFile** disables file caching to obtain the highest possible sequential write performance.

An AutoDMA buffers is saved to disk when an application calls AlazarWaitNextAsyncBufferComplete. For best performance, set the BytesToCopy parameter in AlazarWaitNextAsyncBufferComplete to zero so that data is written to disk without copying data to the user-supplied buffer.

**See Also**

AlazarWaitNextAsyncBufferComplete
Using asynchronous AutoDMA

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### 3.2.22 AlazarErrorToText

Convert a numerical return code to a NULL terminated string.

**Syntax**

```
C/C++
const char* AlazarErrorToText(RETURN_CODE retCode);
```

```
VisualBasic
AlazarErrorToText(ByVal retCode As Long) As String
```

**Parameters**

*retCode*

[in] Return code from API function.

**Return value**

Null terminated or VB string containing the identifier name.

**Remarks**

It is often easier to work with a descriptive error name rather than an error number. For example:

```
RETURN_CODE retCode = ApiSuccess;
printf("Return code %u means %s.\n"),
   retCode,
   AlazarErrorToText(retCode));
```

The output from this code would be the following:

```
Return code 512 means ApiSuccess.
```

**See Also**

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### 3.2.23 AlazarEvents

**This function is deprecated. Do not use in new designs.**

This function allows a user to enable or disable usage of software events in AutoDMA mode. The driver manages the event processing and a user can only use an event in conjunction with the API AlazarWaitForBufferReady (...). When the events are enabled AlazarWaitForBufferReady(...) will wait until an AutoDMA buffer is available to the users application. For a complete understanding of the Usage of the API AlazarEvents (...) refer to the pseudo-code example provided in the API AlazarWaitForBufferReady (...).

**Syntax**

```
C/C++
RETURN_CODE
AlazarEvents(
      HANDLE h,
      U32 enable
);
```

```
VisualBasic
AlazarEvents( _
      ByVal h As Integer, _
      ByVal enable As Integer _
) As Integer
```

**Parameters**

*h*

[in] Handle to the device.

*enable*

[in] This parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| SW_EVENTS_OFF | 0 | Disable events usage |
| SW_EVENTS_ON | 1 | Enable event usage |

**Return value**

ApiSuccess (512) signifies that the API was able to enable the events

ApiFailed (513) signifies that the current driver does not support this feature

**Remarks**

This functionality is only present on the ATS460, ATS660 and ATSS860 devices. It must be called before calling AlazarStartAutoDMA().

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If AlazarEvents(h,1) was not used, calling AlazarWaitForBuffer(…) will return 672 and will not disrupt any ongoing signal captures.

**See Also**

AlazarWaitForBufferReady
Using synchronous AutoDMA

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### 3.2.24 AlazarFreeBufferU16

Free a buffer allocated with AlazarAllocBufferU16.

**Syntax**

```
C/C++
RETURN_CODE
AlazarFreeBufferU16 (
      HANDLE BoardHandle,
      U16*    Buffer
);
```

```
VisualBasic
AlazarFreeBufferU16 ( _
      ByVal BoardHandle As Long, _
      ByVal Buffer As Long_
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to the device.

*Buffer*
[in] Base address of buffer.

**Return value**

If this function succeeds, it returns ApiSuccess (512).

If this function fails, it returns a value other than ApiSuccess (512). See Table 2 for a list of error codes.

**Remarks**

This function must be called to release a buffer allocated by AlazarAllocBufferU16.

**See Also**

AlazarAllocBufferU16
AlazarAllocBufferU8
AlazarFreeBufferU8

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### 3.2.25 AlazarFreeBufferU8

Free a buffer allocated with AlazarAllocBufferU8.

**Syntax**

```
C/C++
RETURN_CODE
AlazarFreeBufferU8(
      HANDLE BoardHandle,
      U8*    Buffer
);
```

```
VisualBasic
AlazarFreeBufferU8( _
      ByVal BoardHandle As Long, _
      ByVal Buffer As Long_
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to the device.

*Buffer*
[in] Base address of buffer.

**Return value**

If this function succeeds, it returns ApiSuccess (512).

If this function fails, it returns the value other than ApiSuccess (512). See Table 2 for a list of error codes.

**Remarks**

This function must be called to free a buffer allocated with AlazarAllocBufferU8.

**See Also**

AlazarAllocBufferU16
AlazarAllocBufferU8
AlazarFreeBufferU16

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### 3.2.26 AlazarFlushAutoDMA

**This function is deprecated. Do not use in new designs.**

The primary use of the API is to stop a Synchronous NPT acquisition. Scanning type applications are usually configured such that the data capture is ongoing and stopping is done by an external event. In this case trigger events have stopped and this API permits the last buffer to be returned to the application.

**Syntax**

```
C/C++
long AlazarFlushAutoDMA (HANDLE h);
```

```
VisualBasic
AlazarEvents(ByVal h As Integer) As Long
```

**Parameters**

*h*

[in] Handle to the device.

**Return value**

The number of valid triggers in the last buffer.

**Remarks**

Suppose an acquisition is running and all of the sudden, triggers stop coming in. Once the software has determined that the acquisition is to be aborted, **AlazarFlushAutoDMA** should be called. The routine will automatically generate the missing triggers in order to complete the last buffer.

A last call to AlazarGetNextAutoDMABuffer is needed to read the LAST buffer. You will get ApiFailed as a return value from AlazarGetNextAutoDMABuffer indicating a successful last buffer. At this point, depending on your design, you may terminate the program or start a new acquisition.

NOTE:
Internally, this routine calls AlazarStopAutoDMA so as not to allow the software to re arm any new DMA requests. Only a call to AlazarStartAutoDMA will reset this action.

**See Also**

AlazarGetNextAutoDMABuffer
AlazarStartAutoDMA
Using synchronous AutoDMA

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### 3.2.27 AlazarForceTrigger

Generate a software trigger event.

**Syntax**

```
C/C++
RETURN_CODE
AlazarForceTrigger (
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarForceTrigger( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

None

**See Also**

AlazarSetExternalTrigger
AlazarSetTriggerDelay
AlazarSetTriggerOperation
AlazarSetTriggerTimeOut

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### 3.2.28 AlazarForceTriggerEnable

Generate a software trigger enable event.

**Syntax**

```
C/C++
RETURN_CODE
AlazarForceTriggerEnable (
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarForceTriggerEnable( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

If the AUX I/O connector has been configured as a trigger enable input, an application can call this function to generate a software trigger enable event while the board is waiting for hardware to supply an edge to the the AUX input.

If the AUX I/O connector has been configured as a trigger enable output, an application should call this function to generate a trigger enabe event.

**See Also**

AlazarConfigureAuxIO

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### 3.2.29 AlazarGetAutoDMAHeaderTimeStamp

**This function is obsolete. Do not use in new designs.**

This routine is a helper function, which can be used to retrieve the 40-bit TimeStamp from the header of a particular record. The resulting number is composed of both the TimeStampHighPart and TimeStampLowPart thus alleviating the user from calculating the time stamp using the header values.

**Syntax**

```
C/C++
float
AlazarGetAutoDMAHeaderTimeStamp(
      HANDLE h,
      U32 Channel,
      void* DataBuffer,
      U32 Record,
      AUTODMA_STATUS *error
);
```

```
VisualBasic
AlazarGetAutoDMAHeaderTimeStamp(_
      ByVal h As Integer, _
      ByVal Channel As Long, _
      ByRef DataBuffer As Any, _
      ByVal Record As Long, _
      ByRef error As Long _
) As Double
```

**Parameters**

*h*

[in] Handle to the device.

*Channel*

[in] This parameter may be one of the following identifiers or values.

| Identifier | Value |
|---|---|
| CHANNEL_A | 1 |
| CHANNEL_B | 2 |

*DataBuffer*

[in] The data buffer as returned from AlazarGetNextAutoDMABuffer.

*Record*

[in] Signifies the record number of interest for the given Data Buffer.

*Error*

[out] Error return code.

This error code may be one of the following values.

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| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

**Return value**

Upon success, i.e. error==ADMA_Success, the TimeStamp will be returned in a floating-point format.

If an error has occurred then 0 will be returned.

**Remarks**

**See Also**

AlazarGetAutoDMAHeaderValue
AlazarGetAutoDMAPtr

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### 3.2.30 AlazarGetAutoDMAHeaderValue

**This function is deprecated. Do not use in new designs.**

This routine is a helper function that can be used to retrieve all the various elements available in the header of an AutoDMA record. It will only operate on records that were captured when the Use Header variable in AlazarStartAutoDMA was set to a 1.

**Syntax**

```
C/C++
U32
AlazarGetAutoDMAHeaderValue(
      HANDLE h,
      U32 Channel,
      void* DataBuffer,
      U32 Record,
      U32 Parameter,
      AUTODMA_STATUS *error
);
```

```
VisualBasic
AlazarGetAutoDMAHeaderValue(_
      ByVal h As Integer, _
      ByVal Channel As Long, _
      ByRef DataBuffer As Any, _
      ByVal Record As Long, _
      ByVal Parameter As Long, _
      ByRef error As Long _
) As Long
```

**Parameters**

*h*

[in] Handle to the device.

*Channel*

[in] This parameter may be one of the following identifiers or values.

| Identifier | Value |
|---|---|
| CHANNEL_A | 1 |
| CHANNEL_B | 2 |

*DataBuffer*

[in] The data buffer as returned from AlazarGetNextAutoDMABuffer.

*Record*

[in] Signifies the record number of interest for the provided Data Buffer.

*Parameter*

[in] Signifies which element the routine should extract from the record's header.

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This parameter may be one of the following identifiers or values.

| Identifier | Value |
|---|---|
| ADMA_CLOCKSOURCE | 1 |
| ADMA_CLOCKEDGE | 2 |
| ADMA_SAMPLERATE | 3 |
| ADMA_INPUTRANGE | 4 |
| ADMA_INPUTCOUPLING | 5 |
| ADMA_IMPUTIMPEDENCE | 6 |
| ADMA_EXTTRIGGERED | 7 |
| ADMA_CHA_TRIGGERED | 8 |
| ADMA_CHB_TRIGGERED | 9 |
| ADMA_TIMEOUT | 10 |
| ADMA_THISCHANTRIGGERED | 11 |
| ADMA_SERIALNUMBER | 12 |
| ADMA_SYSTEMNUMBER | 13 |
| ADMA_BOARDNUMBER | 14 |
| ADMA_WHICHCHANNEL | 15 |
| ADMA_SAMPLERESOLUTION | 16 |
| ADMA_DATAFORMAT | 17 |

*Error*

[out] Error return code.

This error code may be one of the following values.

| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

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**Return value**

IF error==ADMA_Success, then the value of the asked Parameter is returned.

**Remarks**

**See Also**

AlazarGetAutoDMAPtr
AlazarGetAutoDMAHeaderTimeStamp

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### 3.2.31 AlazarGetAutoDMAPtr

**This function is deprecated. Do not use in new designs.**

This routine is a helper function used to retrieve a pointer to the first data element or first header element of a particular record. If DataOrHeader is set to 1, then the resulting pointer must be cast to PALAZAR_HEADER type. The user can then use the pointer to access any of the header variables.
Ex. PALAZAR_HEADER p = (PALAZAR_HEADER) AlazarGetAutoDMAPtr (…);

**Syntax**

C/C++

```
void *
AlazarGetAutoDMAPtr(
      HANDLE h,
      U32 DataOrHeader,
      U32 Channel,
      void* DataBuffer,
      U32 Record,
      AUTODMA_STATUS *error
);
```

VisualBasic

```
NOT SUPPORTED
```

**Parameters**

*h*

[in] Handle to the device.

*DataOrHeader*

[in] Instruct the routine to return a pointer for the data or header portion.

This parameter may be one of the following values.

| Value | Meaning |
|---|---|
| 0 | Return the pointer for the data portion. |
| 1 | Return the pointer for the header portion. |

*Channel*

[in] This parameter may be one of the following identifiers or values.

| Identifier | Value |
|---|---|
| CHANNEL_A | 1 |
| CHANNEL_B | 2 |

*DataBuffer*

[in] The data buffer as returned from AlazarGetNextAutoDMABuffer.

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*Record*

[in] Signifies the record number of interest for the given Data Buffer.

*Error*

[out] Error return code.

This error code may be one of the following values.

| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

**Return value**

See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarGetAutoDMAHeaderTimeStamp
AlazarGetAutoDMAHeaderValue

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### 3.2.32 AlazarGetBoardBySystemHandle

Get a handle to a board in a board system where the board system is specified by a handle to its master board, and the board by its identifier within the board system.

**Syntax**

```
C/C++
HANDLE
AlazarGetBoardBySystemHandle (
      HANDLE BoardHandle,
      U32 BoardId
);
```

```
VisualBasic
AlazarGetBoardBySystemHandle( _
      ByVal BoardHandle As Integer, _
      ByVal BoardId As Integer _
) As Integer
```

**Parameters**

*BoardHandle*
[in] Handle to master board.

*BoardId*
[in] Board identifier in board system.

**Return value**

This function returns a handle to the specified board if it was found.

The function returns NULL if the master board handle is invalid, or a board with the specified board identifier was not found in the specified board system.

**Remarks**

The board identifier of a master board in a board system is always 1.

**See Also**

AlazarGetBoardBySystemID
AlazarGetSystemHandle

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### 3.2.33 AlazarGetBoardBySystemID

Get a handle to a board in a board system where the board system is specified its system identifier and the board by its board identifier within the board system.

**Syntax**

```
C/C++
HANDLE
AlazarGetBoardBySystemID (
      U32 SystemId,
      U32 BoardId
);
```

```
VisualBasic
Public Declare Function AlazarGetBoardBySystemID( _
      ByVal SystemId As Integer, _
      ByVal BoardId As Integer _
) As Integer
```

**Parameters**

*SystemId*

[in] System identifier number.

*BoardId*

[in] Board identifier in system.

**Return value**

This function returns a handle to the specified board if it was found.

It returns NULL if the board system with the specified ID was not found, or a board with the specified ID was not found within the specified board system.

**Remarks**

**See Also**

AlazarGetBoardBySystemHandle
AlazarGetSystemHandle

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### 3.2.34 AlazarGetBoardKind

Get a board model identifier of the board associated with a board handle.

**Syntax**

```
C/C++
U32 AlazarGetBoardKind (
      HANDLE BoardHandle
);
```

```
VisualBasic
Public Declare Function AlazarGetBoardKind(_
      ByVal BoardHandle As Integer _
) As Integer
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the function succeeds, it returns a non-zero board model identifier.

If the function fails, it returns 0.

**Remarks**

The following lists currently supported board model identifiers and their values. See AlazarApi.h for a complete list of board type identifiers.

| Identifier | Value |
|---|---|
| ATS850 | 1 |
| ATS310 | 2 |
| ATS330 | 3 |
| ATS460 | 7 |
| ATS860 | 8 |
| ATS660 | 9 |
| ATS9462 | 11 |
| ATS9870 | 13 |
| ATS9350 | 14 |
| ATS9325 | 15 |
| ATS9440 | 16 |
| ATS9410 | 17 |
| ATS9351 | 18 |
| ATS9850 | 21 |
| ATS9625 | 22 |
| ATS9626 | 24 |

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| | |
|---|---|
| ATS9360 | 25 |

**See Also**

### 3.2.35 AlazarGetBoardRevision

Get the PCB hadware revision level of a digitizer board.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetBoardRevision (
      HANDLE *boardHandle,
      U8 *MajorVersion,
      U8 *MinorVersion
);
```

```
VisualBasic
AlazarGetBoardRevision ( _
      ByVal Boardhandle As Long, _
      ByRef MajorVersion As Byte, _
      ByRef MinorVersion As Byte _
) As Long
```

**Parameters**

*BoardHandle*
[in] Board handle.

*MajorVersion*
[out] PCB major version number.

*RevisionNumber*
[out] PCB minor version number.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

AlazarTech periodically updates the PCB hadware of its digitizers to improve functionality. Many PCIE digitizers can report the PCB hadware revision to software. Note that this function is not supported on PCI digitizer boards.

**See Also**

AlazarGetCPLDVersion
AlazarGetSDKVersion

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### 3.2.36 AlazarGetChannelInfo

Get the on-board memory in samples per channel, and sample size in bits per sample.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetChannelInfo (
      HANDLE BoardHandle,
      U32 *MemorySizeInSamples,
      U8 *BitsPerSample
);
```

```
VisualBasic
AlazarGetChannelInfo( _
      ByVal BoardHandle As Integer, _
      ByRef MemorySizeInSamples As Long, _
      ByRef BitsPerSample As Byte _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*MemorySizeInSamples*
[out] The on-board memory size in samples per channel.

*bitsPerSample*
[out] The number of bits per sample.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The ATS9325, ATS9350, ATS9351, ATS9625, ATS9626, ATS9850 and ATS9870 can dedicate all on-board memory to a single channel. The on-board memory size reported by these boards is the maximum samples per channel in single channel mode. In dual-channel mode, the on-board memory is shared equally between both channels.

The ATS9440 with 4-input channels can dedicate all on-board memory to a single channel, two channels, or four channels. The on-board memory size reported by these boards is the maximum samples per channel in single channel mode. In dual-channel mode, the on-board memory is shared equally between two channels. And in four channel

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mode, the on-board memory is shared equally between all four channels. The digitizer does not support 3-channel operation.

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### 3.2.37 AlazarGetCPLDVersion

Get the CPLD version number of the specified board.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetCPLDVersion(
      HANDLE  BoardHandle,
      U8 *MajorNumber,
      U8 *MinorNumber
);
```

```
VisualBasic
AlazarGetCPLDVersion( _
      ByVal BoardHandle As Integer, _
      ByRef MajorNumber As Byte, _
      ByRef MinorNumber As Byte _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*MajorNumber*
[out] The CPLD major revision number.

*MinorNumber*
[out] The CPLD minor revision number.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarGetDriverVersion
AlazarGetSDKVersion

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### 3.2.38 AlazarGetDriverVersion

Get the device driver version of the most recently opened device.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetDriverVersion (
      U8 *MajorNumber,
      U8 *MinorNumber,
      U8 *RevisionNumber
);
```

```
VisualBasic
AlazarGetDriverVersion( _
      ByRef MajorNumber As Byte, _
      ByRef MinorNumber As Byte, _
      ByRef RevisionNumber As Byte _
) As Long
```

**Parameters**

*MajorNumbr*
[out] The driver major version number.

*MinorNumber*
[out] The driver minor version number.

*RevisionNumber*
[out] The driver revision number.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

Driver releases are given a version number with the format X.Y.Z where: X is the major release number, Y is the minor release number, and Z is the minor revision number.

**See Also**

AlazarGetCPLDVersion
AlazarGetSDKVersion

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### 3.2.39 AlazarGetMaxRecordsCapable

Calculate the maximum number of records that can be captured to on-board memory given the requested number of samples per record.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetMaxRecordsCapable (
      HANDLE BoardHandle,
      U32 SamplesPerRecord,
      U32 *MaxRecordsPerCapture
);
```

```
VisualBasic
AlazarGetMaxRecordsCapable( _
      ByVal BoardHandle As Integer, _
      ByVal SamplesPerRecord As Long, _
      ByRef MaxRecordsPerCapture As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] The handle a board in a board system.

*SamplesPerRecord*

[in] The desired number of samples per record.

*MaxRecordsPerCapture*

[out] The maximum number of records per capture possible with the requested samples per record.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

This function is part of the single port API. It should not be used with AutoDMA API functions.

**See Also**

AlazarHyperDisp
AlazarRead
AlazarReadEx

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### 3.2.40 AlazarGetNextAutoDMABuffer

**This function is deprecated. Do not use in new designs.**

After an application has called AlazarStartAutoDMA the application must call AlazarGetNextAutoDMABuffer to retrieve the data buffers. Because of the nature of Auto Dma, two buffers are required. The device driver dll will arbitrate to which buffer the data will be returned. After a buffer has been filled, variable WhichOne equals the buffer id, thus if the id is 0 then Buffer1 was used and likewise if the id is 1 then Buffer2 was used. In the case where data is not available WhichOne will equal -1. This routine will always return ApiSuccess (512) when either data has been transferred or when WhichOne = -1. A return value of ApiFailed (513) indicates that all the Records Per Buffer has been transferred.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetNextAutoDMABuffer(
      HANDLE h,
      void* Buffer1,
      void* Buffer2,
      long* WhichOne,
      long* RecordsTransferred,
      AUTODMA_STATUS* error,
      U32 r1,
      U32 r2,
      long *TriggersOccurred,
      U32 * r4
);
```

```
VisualBasic
AlazarGetNextAutoDMABuffer( _
      ByVal h As Integer, _
      ByRef Buffer1 As Any, _
      ByRef Buffer2 As Any, _
      ByRef WhichOne As Long, _
      ByRef RecordsTransferred As Long, _
      ByRef error As Long, _
      ByVal r1 As Long, _
      ByVal r2 As Long, _
      ByRef TriggersOccurred As Long, _
      ByRef r4 As Long _
) As Long
```

**Parameters**

*h*

[in] Handle to the device.

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*Buffer1*

[out] This Buffer is used to transfer a complete set of Records from the Device back to the user application. It is one of two buffers that are alternated between. The second buffer is Buffer2.

Buffer1 should be large enough to contain (RecordsPerBuffer*TransferLength) many 16-bit values (VB-Integer, C&C++-short).

If the Record header is selected (UseHeader = 1) then Buffer1 should be large enough to hold (RecordsPerBuffer*(TransferLength+sizeof(ALAZAR_HEADER)) many 16bit values.

*Buffer2*

[out] This Buffer is used to transfer a complete set of Records from the Device back to the user. It is one of two buffers that are alternated between. The other buffer is Buffer1.

Buffer2 should be large enough to contain (RecordsPerBuffer*TransferLength) many 16-bit values (VB-Integer, C&C++-short).

If the Record header is selected (UseHeader = 1) then Buffer2 should be large enough to hold.

*WhichOne*

[out] This is a return value that indicates to the user which of the two Buffers (Buffer1 or Buffer2) the data was transferred into.

*RecordsTransferred*

[in | out] Indicates how many records have been transferred. This value will always be a multiple of RecordsPerBuffer. It is the application's responsibility to initialize the variable to 0 prior to the first call.

*Error*

[out] Error code.

This error code may be one of the following values.

| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |

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| | | |
|---|---|---|
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

*r1*

[in] RESERVED.

*r2*

[in] RESERVED.

*TriggersOccurred*

[out] This is the total number of triggers that have been captured since the last start capture.

*r4*

[out] RESERVED.

**Return value**

See Table 2 for a list of error codes.

**Remarks**

Both Buffer1 and Buffer2 will be used in transferring the data from the device back to the user application. However, if the RecordsPerBuffer is set in conjunction with TransferLength such that all the data will fit in only one Buffer, then Only Buffer1 will be used and the WhichOne variable will equal 0. Only one transaction will take place. RecordsTransferred will be modified by the routine and is used to accumulate the number of record that has been transferred. Always set the variable to 0 before calling this routine and never modify its contents between repeating calls.

The user must ensure that Buffer1 and Buffer2 are valid buffers.

Buffer1 and Buffer2 should be large enough to contain (RecordsPerBuffer*TransferLength) many 16-bit values (VB-Integer, C&C++-short). If the Record header is selected (UseHeader = 1) then Buffer1 and Buffer2 should be large enough to hold (RecordsPerBuffer*(TransferLength+sizeof(ALAZAR_HEADER)) many 16bit values (VB-Integer, C&C++-short).

AlazarGetNextBuffer and **AlazarGetNextAutoDMABuffer** are identical.

**See Also**

AlazarStartAutoDMA
AlazarAbortAutoDma
AlazarGetNextBuffer
Using synchronous AutoDMA

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### 3.2.41 AlazarGetNextBuffer

**This function is deprecated. Do not use in new designs.**

**AlazarGetNextBuffer** and AlazarGetNextAutoDMABuffer are identical. Please refer to AlazarGetNextAutoDMABuffer.

#### Syntax

C/C++

```
RETURN_CODE
AlazarGetNextBuffer (
      HANDLE h,
      void* Buffer1,
      void* Buffer2,
      long* WhichOne,
      long* RecordsTransferred,
      AUTODMA_STATUS* error,
      U32 r1,
      U32 r2,
      long *TriggersOccurred,
      U32 * r4
);
```

VisualBasic

```
AlazarGetNextBuffer( _
      ByVal h As Integer, _
      ByRef Buffer1 As Any, _
      ByRef Buffer2 As Any, _
      ByRef WhichOne As Long, _
      ByRef RecordsTransferred As Long, _
      ByRef error As Long, _
      ByVal r1 As Long, _
      ByVal r2 As Long, _
      ByRef TriggersOccurred As Long, _
      ByRef r4 As Long _
) As Long
```

#### Remarks

**AlazarGetNextBuffer** and AlazarGetNextAutoDMABuffer are identical.

#### See Also

See AlazarGetNextAutoDMABuffer.

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### 3.2.42 AlazarGetParameter

Get a device attribute as a signed long value.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetParameter(
      HANDLE BoardHandle,
      U8 Channel
      U32 Parameter,
      long *Value
);
```

```
VisualBasic
AlazarGetParameter( _
      ByVal BoardHandle As Integer, _
      ByVal Channel As Byte, _
      ByVal Parameter As Long, _
      ByRef Value As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Channel*

[in] The channel of the attribute, if required.

*Parameter*

[in] The parameter identifier.

Parameter identifiers include the following values. See AlazarApi.h for a complete list of list of identifiers.

| Value | Meaning |
|---|---|
| DATA_WIDTH<br>0x10000009 | Get the number of bits per sample. |
| SETGET_ASYNC_BUFFSIZE_BYTES<br>0x10000039 | Get the size in bytes of each API allocated DMA. |
| SETGET_ASYNC_BUFFCOUNT<br>0x10000040 | Get the number of API allocated DMA buffers. |
| GET_DATA_FORMAT<br>0x10000042 | Return 0 if the data format is unsigned, or 1 if the data format is signed. |
| GET_SAMPLES_PER_TIMESTAMP_CLOCK<br>0x10000044 | Get the number of sample clocks per timestamp clock |
| GET_RECORDS_CAPTURED | Get the current number of |

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| | |
|---|---|
| 0x10000045 | number of records captured since the start of the acquisition (single-port) or buffer (dual-port). |
| GET_ASYNC_BUFFERS_PENDING 0x10000050 | Get the number of DMA buffers that have been queued by an application to this board. |
| GET_ASYNC_BUFFERS_PENDING_FULL 0x10000051 | Get the number of DMA buffers for this board that are full and waiting to be processed by the application. |
| GET_ASYNC_BUFFERS_PENDING_EMPTY 0x10000052 | Get the number of DMA buffers for this board that are empty and waiting to be filled by the board. |
| ECC_MODE 0x10000048 | Get ECC mode: 0 = ECC is disabled, 1 = ECC enabled. |
| GET_AUX_INPUT_LEVEL 0x10000049 | Read the TTL level of the AUX connector when it is configured as a serial input. 0 = TTL low, 1 = TTL high. |
| GET_CHANNELS_PER_BOARD 0x10000070 | Get the number of analog input channels supported by the digitizer. |
| PACK_MODE 0x10000072 | Get the data packing mode. 0 = PACK_DEFAULT, 1 = PACK_8_BITS_PER_SAMPLE |
| GET_FPGA_TEMPERATURE 0x10000080 | Get the digitizer's current FPGA temperature in degrees Celcuis. This function is only supported on PCIe digitizers. |

*Value*

[out] The parameter's value.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarGetParameterUL
AlazarSetParameter

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AlazarSetParameterUL

### 3.2.43 AlazarGetParameterUL

Get a device attribute as an unsigned 32-bit value.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetParameterUL (
      HANDLE BoardHandle,
      U8 Channel
      U32 Parameter,
      U32 *Value
);
```

```
VisualBasic
AlazarGetParameterUL( _
      ByVal BoardHandle As Integer, _
      ByVal Channel As Byte, _
      ByVal Parameter As Long, _
      ByRef Value As Long  _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Channel*

[in] The channel of the attribute, if required.

*Parameter*

[in] The parameter identifier.

See AlazarApi.h for a complete list of list of identifiers.

*Value*

[out] The parameter's value.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

See AlazarApi.h for a complete list of list of parameter identifiers.

**See Also**

AlazarGetParameter

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AlazarSetParameter
AlazarSetParameterUL

### 3.2.44 AlazarGetSDKVersion

Get the driver library version. This is the version of ATSApi.dll under Windows, or ATSApi.so under Linux.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetSDKVersion (
      U8 *MajorNumber,
      U8 *MinorNumber,
      U8 *RevisionNumber
);
```

```
VisualBasic
AlazarGetSDKVersion( _
      ByRef MajorNumber As Byte, _
      ByRef MinorNumber As Byte, _
      ByRef RevisionNumber As Byte _
) As Long
```

**Parameters**

*MajorNumber*
[out] The SDK major version number.

*MinorNumber*
[out] The SDK minor version number.

*RevisionNumber*
[out] The SDK revision number.

**Return value**

The function returns ApiSuccess (512) if it was successful.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

Note that the version number returned is that of the driver library file, not the ATS-SDK version number.

SDK releases are given a version number with the format X.Y.Z where: X is the major release number, Y is the minor release number, and Z is the minor revision number.

**See Also**

AlazarGetCPLDVersion
AlazarGetDriverVersion

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### 3.2.45 AlazarGetStatus

Return a bitmask with board status information.

**Syntax**

```
C/C++
U32 AlazarGetStatus (
      HANDLE BoardHandle
);
```

```
VisualBasic
AlazarGetStatus( _
      ByVal BoardHandle As Integer, _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the function fails, the return value is 0xffffffff.

If the function succeeds, the return value is contains board attributes. The attributes can include one or more of the following values.

| Attribute | Meaning |
|---|---|
| 1 | At least one trigger timeout occurred. |
| 2 | At least one CHA sample was out of range during the last acquisition. |
| 4 | At least one CHB sample was out of range during the last acquisition |
| 8 | The PLL is locked (ATS660 only). |

**Remarks**

**See Also**

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### 3.2.46 AlazarGetSystemHandle

Return the handle of the master board in the specified board system.

**Syntax**

```
C/C++
HANDLE
AlazarGetSystemHandle (
      U32 SystemId
);
```

```
VisualBasic
AlazarGetSystemHandle( _
      ByVal SystemId As Integer _
) As Integer
```

**Parameters**

*SystemId*
[in] System identification number.

**Return value**

If this function succeeds, it returns a handle to the master board in the specified board system.

If the function fails, it returns NULL.

**Remarks**

If the board system specified contains a single, independent board, this function returns a handle to that board.

**See Also**

AlazarBoardsInSystemByHandle
AlazarBoardsInSystemBySystemID

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### 3.2.47 AlazarGetTriggerAddress

Get the timestamp and trigger address of the trigger event in a record acquired to on-board memory.

**Syntax**

C/C++

```
RETURN_CODE
AlazarGetTriggerAddress (
      HANDLE BoardHandle,
      U32 Record,
      U32 *TriggerAddress,
      U32 *TimestampHighPart,
      U32 *TimestampLowPart
);
```

VisualBasic

```
AlazarGetTriggerAddress( _
      ByVal BoardHandle As Integer, _
      ByVal Record As Long, _
      ByRef TriggerAddress As Long, _
      ByRef TimestampHighPart As Long, _
      ByRef TimestampLowPart As Long _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*Record*
[in] Record in acquisition (1-indexed).

*TriggerAddress*
[in] The trigger address.

*TimestampHighPart*
[in] The most significant 32-bits of a record timestamp.

*TimestampLowPart*
[in] The least significant 8-bits of a record timestamp.

**Return value**

The function returns ApiSuccess (512) if it was successful.

The function returns ApiError (604) if it is called after completing a dual-ported AutoDMA acquisition. It should be called after completing a single-ported acquisition.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

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**Remarks**

This function is part of the single-port data acquisition API. It cannot be used to retrieve the timestamp of records acquired using dual-port AutoDMA APIs.

The following code fragment demonstrates how to convert the trigger timestamp returned by **AlazarGetTriggerAddress** from counts to seconds.

```
__int64 timeStamp_cnt;
timeStamp_cnt = ((__int64) timestampHighPart) << 8;
timeStamp_cnt |= timestampLowPart & 0x0ff;

double samplesPerTimestampCount = 2; // board specific constant
double samplesPerSec = 50.e6;        // sample rate
double timeStamp_sec = (double) samplesPerTimestampCount *
    timeStamp_cnt / samplesPerSec;
```

The following table lists the board specific "sample clocks per timestamp count" values.

| Model | Samples clocks per timestamp count |
|---|---|
| ATS310, ATS330, ATS460, ATS660, ATS9462, ATS9850, ATS9870, ATS9325, ATS9350, ATS9351 | 2 |
| ATS850, ATS860, ATS9625, ATS9626 | 4 |

**Example**

See "%ATS_SDK_DIR%\Samples\SinglePort\AR_Timestamp" for a complete sample program demonstrates how to use AlazarGetTriggerAddress and convert the timestamp value to seconds.

**See Also**

AlazarRead
AlazarHyperDisp

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### 3.2.48 AlazarGetTriggerTimestamp

Retrieve the timestamp, in sample clock periods, of a record acquired to on-board memory.

**Syntax**

```
C/C++
RETURN_CODE
AlazarGetTriggerTimestamp (
      HANDLE BoardHandle,
      U32 Record,
      U64 *Timestamp_samples
);
```

```
VisualBasic
AlazarGetTriggerTimestmap( _
      ByVal BoardHandle As Integer, _
      ByVal Record As Long, _
      ByRef Timestamp_samples As Currency _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*Record*
[in] Record in acquisition (1-indexed).

*Timestamp*
[out] Record timestamp, in sample clock periods.

**Return value**

The function returns ApiSuccess (512) and if it was successful.

The function returns ApiError (604) if the record parameter is greater than 1000 in a dual-port AutoDMA acquisition.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

This function is part of the single-port data acquisition API. It cannot be used to retrieve the timestamp of records acquired using dual-port AutoDMA APIs.

Divide by the trigger timestamp value in sample clock periods by the sample rate to obtain the trigger timestamp value in seconds. For example:

```
// Get the trigger timestamp of the first record in sample clocks
```

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```
U64 timestmap_samples;
AlazarGetTriggerTimestamp(handle, 1, &timestamp_samples);

// Convert the timestamp from sample clocks to seconds
double samplesPerSec = 100.e6;
double timestamp_seconds = timestmap_samples / samplesPerSec;
```

**See Also**

AlazarRead
AlazarHyperDisp

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### 3.2.49 AlazarGetWhoTriggeredBySystemHandle

Return which event caused a board system to trigger and capture a record to on-board memory.

**Syntax**

```
C/C++
U32
AlazarGetWhoTriggeredBySystemHandle (
      HANDLE BoardHandle,
      U32 BoardId,
      U32 RecordNumber
);
```

```
VisualBasic
AlazarGetWhoTriggeredBySystemHandle( _
      ByVal BoardHandle As Integer, _
      ByVal BoardId as Integer, _
      ByVal RecordNumber as Integer _
) As Integer
```

**Parameters**

*BoardHandle*

[in] Handle to master board in a board system.

*BoardId*

[in] Board identifier of a board in the specified board system.

*RecordNumber*

[in] Record in acquisition (1-indexed).

**Return value**

The function returns one of the following values.

| Value | Meaning |
|---|---|
| 0 | This board did not cause the system to trigger. |
| 1 | CH A on this board caused the system to trigger. |
| 2 | CH B on this board caused the system to trigger. |
| 3 | EXT TRIG IN on this board caused the system to trigger. |
| 4 | Both CH A and CH B on this board caused the system to trigger. |
| 5 | Both CH A and EXT TRIG IN on this board caused the system to trigger. |
| 6 | Both CH B and EXT TRIG IN on this board caused the system to trigger. |
| 7 | A trigger timeout on this board caused the system to trigger. |

**Remarks**

This function is part of the single-port data acquisition API. It cannot be used with the dual-port AutoDMA APIs.

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This API routine will not work with ATS850 version 1.2 hardware. Version 1.3 and higher version number of ATS850 are fully supported, as are all versions of ATS330 and ATS310.

**See Also**

AlazarGetWhoTriggeredBySystemId

### 3.2.50 AlazarGetWhoTriggeredBySystemID

Return which event caused a board system to trigger and capture a record to on-board memory.

**Syntax**

```
C/C++
U32
AlazarGetWhoTriggeredBySystemID (
      U32 SystemId,
      U32 BoardId,
      U32 RecordNumber
);
```

```
VisualBasic
AlazarGetWhoTriggeredBySystemHandle( _
      ByVal SystemId As Integer, _
      ByVal BoardId as Integer, _
      ByVal RecordNumber as Integer _
) As Integer
```

**Parameters**

*SystemId*

[in] System identifier number.

*BoardId*

[in] Board identifier of a board in the specified board system.

*RecordNumber*

[in] Record in acquisition (1-indexed).

**Return value**

The function returns one of the following values.

| Value | Meaning |
|---|---|
| 0 | This board did not cause the system to trigger. |
| 1 | CH A on this board caused the system to trigger. |
| 2 | CH B on this board caused the system to trigger. |
| 3 | EXT TRIG IN on this board caused the system to trigger. |
| 4 | Both CH A and CH B on this board caused the system to trigger. |
| 5 | Both CH A and EXT TRIG IN on this board caused the system to trigger. |
| 6 | Both CH B and EXT TRIG IN on this board caused the system to trigger. |
| 7 | A trigger timeout on this board caused the system to trigger. |

**Remarks**

This function is part of the single-port data acquisition API. It cannot be used with the dual-port AutoDMA APIs.

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Note that this API routine will not work with ATS850 version 1.2 hardware. Version 1.3 and higher version number of ATS850 are fully supported, as are all versions of ATS330 and ATS310.

**See Also**

AlazarGetWhoTriggeredBySystemHandle

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### 3.2.51 AlazarHyperDisp

Enable the on-board FPGA to process records acquired to on-board memory, and transfer the processed data to host memory.

**Syntax**

```
C/C++
RETURN_CODE
AlazarHyperDisp(
      HANDLE  BoardHandle,
      void   *Buffer,
      U32     BufferSize,
      U8     *ViewBuffer,
      U32     ViewBufferSize,
      U32     NumOfPixels,
      U32     Option,
      U32     ChannelSelect,
      U32     Record,
      long    TransferOffset,
      U32     *Error
);
```

```
VisualBasic
Not supported
```

**Parameters**

*BoardHandle*

[in] Handle to a board.

*Buffer*

[in] Reserved (set to NULL).

*BufferSize*

[in] Number of samples to process.

*ViewBuffer*

[out] Pointer to a buffer to receive processed data.

*ViewBufferSize*

[in] Size, in bytes, of processed data buffer.

*NumOfPixels*

[in] Number of HyperDisp points.

*Option*

[in] Processing mode.

| Value | Meaning |
|---|---|
| 1 | Enable HyperDisp processing. |

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*ChannelSelect*
[in] Channel to process.

*Record*
[in] Record to process (1-indexed).

*TransferOffset*
[in] Offset, in samples, of first sample to process relative to trigger position in record.

*Error*
[out] Pointer to value to receive a result code.

**Return values**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**AlazarHyperDisp** is part of the single-port data acquisition API. It cannot be used with the dual-port AutoDMA APIs.

HyperDisp processing enables the on-board FPGA to divide a record acquired to on-board memory into intervals, find the minimum and maximum sample values during each interval, and transfer an array of minimum and maximum sample values to a buffer in host memory. This allows the acquisition of relatively long records to on-board memory, but the transfer of relatively short, processed records to a buffer in host memory.

For example, it would take an ATS860-256M about ~2.5 seconds to transfer a 250,000,000 sample record from on-board memory, across the PCI bus, to a buffer in host memory. With HyperDisp enabled, it would take the on-board FPGA a fraction of a second to process the record and transfer a few hundred samples from on-board memory, across the PCI bus, to a buffer in host memory.

**Example**

The "%ATS_SDK_DIR%\SinglePort\HD" sample program demonstrates how to use the **AlazarHyperDisp** API.

**See Also**

AlazarGetTriggerAddress
AlazarRead
AlazarReadEx

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### 3.2.52 AlazarInputControl

Select the input coupling, range, and impedance of a digitizer channel.

**Syntax**

```
C/C++
RETURN_CODE
AlazarInputControl (
      HANDLE BoardHandle,
      U8 ChannelId,
      U32 CouplingId,
      U32 RangeId,
      U32 ImpedanceId
);
```

```
VisualBasic
AlazarInputControl( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Byte, _
      ByVal CouplingId As Long, _
      ByVal RangeId As Long, _
      ByVal ImpedanceId As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to a board.

*ChannelId*

[in] Select the channel to control. This parameter may be one of the following identifiers or values.

| Identifier | Value |
|---|---|
| CHANNEL_A | 1 |
| CHANNEL_B | 2 |
| CHANNEL_C | 4 |
| CHANNEL_D | 8 |

*CouplingId*

[in] Specify coupling of selected channel. This parameter may be one of the following identifiers or values. See the remarks below.

| Identifier | Value |
|---|---|
| AC_COUPLING | 1 |
| DC_COUPLING | 2 |

*RangeId*

[in] Specify full-scale input range of selected channel. This parameter may be one of the following identifiers or values. See the remarks below.

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ATS310 / ATS330 full-scale input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_40_MV | 2 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_50_MV | 3 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_80_MV | 4 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_100_MV | 5 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_200_MV | 6 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_500_MV | 8 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_800_MV | 9 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_1_V | 10 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_5_V | 13 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_8_V | 14 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_10_V | 15 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_20_V | 16 | 1MΩ or 50Ω |

ATS460 / ATS860 full-scale input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_20_MV | 1 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_40_MV | 2 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_50_MV | 3 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_80_MV | 4 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_100_MV | 5 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_200_MV | 6 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_500_MV | 8 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_800_MV | 9 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_1_V | 10 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_5_V | 13 | 1MΩ |
| INPUT_RANGE_PM_8_V | 14 | 1MΩ |
| INPUT_RANGE_PM_10_V | 15 | 1MΩ |

ATS660 / ATS9462 input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_200_MV | 6 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_800_MV | 9 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 1MΩ or 50Ω |

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| | | |
|---|---|---|
| INPUT_RANGE_PM_8_V | 14 | 1MΩ |
| INPUT_RANGE_PM_16_V | 18 | 1MΩ |

ATS850 full-scale input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_20_MV | 1 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_40_MV | 2 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_50_MV | 3 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_80_MV | 4 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_100_MV | 5 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_200_MV | 6 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_500_MV | 8 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_800_MV | 9 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_1_V | 10 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_5_V | 13 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_8_V | 14 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_10_V | 15 | 1MΩ or 50Ω |
| INPUT_RANGE_PM_20_V | 16 | 1MΩ or 50Ω |

ATS9325 / ATS9350 / ATS9850 / ATS9870 input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_40_MV | 2 | 50Ω |
| INPUT_RANGE_PM_100_MV | 5 | 50Ω |
| INPUT_RANGE_PM_200_MV | 6 | 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 50Ω |
| INPUT_RANGE_PM_1_V | 10 | 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 50Ω |

ATS9351 / ATS9360 input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_400_MV | 7 | 50Ω |

ATS9625 / ATS9626 input ranges

| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_1_V_25 | 33 | 50Ω |

ATS9440 input ranges

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| Identifier | Value | Impedance |
|---|---|---|
| INPUT_RANGE_PM_100_MV | 5 | 50Ω |
| INPUT_RANGE_PM_200_MV | 6 | 50Ω |
| INPUT_RANGE_PM_400_MV | 7 | 50Ω |
| INPUT_RANGE_PM_1_V | 10 | 50Ω |
| INPUT_RANGE_PM_2_V | 11 | 50Ω |
| INPUT_RANGE_PM_4_V | 12 | 50Ω |

*ImpedanceId*

[in] Specify termination of selected channel. This parameter may be one of the following identifiers or values. See the remarks below.

| Identifier | Value |
|---|---|
| IMPEDANCE_1M_OHM | 1 |
| IMPEDANCE_50_OHM | 2 |

**Return values**

If the function succeeds, it returns ApiSuccess (512).

If the digitizer board does not support the specified input range, coupling, or the impedance, the function returns ApiFailed (513).

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The ATS9325, ATS9350, ATS9351, ATS9360, ATS9625, ATS9626, ATS9850 and ATS9870 only support 50Ω input impedance.

**See Also**

AlazarSetBWLimit

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### 3.2.53 AlazarNumOfSystems

Get the total number of board systems detected.

**Syntax**

```
C/C++
U32 AlazarNumOfSystems ();
```

```
VisualBasic
AlazarNumOfSystems() As Integer
```

**Parameters**

None

**Return value**

The total number of board systems detected.

**Remarks**

A *board system* is a group of one or more digitizer boards that share clock and trigger signals. A board system may be composed of a single independent board, or a group of two or more digitizer boards connected together with a SyncBoard.

**See Also**

AlazarBoardsInSystemByHandle
AlazarBoardsInSystemBySystemID

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### 3.2.54 AlazarOEMDownLoadFPGA

Download an FPGA image to a digitizer board.

**Syntax**

```
C/C++
RETURN_CODE
AlazarOEMDownLoadFPGA(
      HANDLE BoardHandle,
      char *FileName,
      U32 *Error
);
```

```
VisualBasic
AlazarOEMDownLoadFPGA(  _
      ByVal BoardHandle As Integer, _
      ByRef FileName As Any, _
      ByRef Error As Long _
) As Integer
```

**Parameters**

*BoardHandle*

[in] Handle to a board.

*FileName*

[in] FPGA image file path.

*Error*

[out] Download result.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**See Also**

AlazarParseFPGAName

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### 3.2.55 AlazarOpen

**This function is obsolete. Do not use in new designs.**

Open and initialize a board.

**Syntax**

```
C/C++
HANDLE
AlazarOpen(
      char *BoardName
);
```

```
VisualBasic
AlazarOpen( _
      ByVal BoardName As String _
) As Integer
```

**Parameters**

*BoardName*
[in] Name of board created by driver. For example "ATS850-0".

**Return value**

A handle to the board.

**Remarks**

The ATS library manages board handles internally. This function should only be used in applications that are written for single board digitizer systems.

**See Also**

AlazarClose

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### 3.2.56 AlazarParseFPGAName

Decode an OEM FPGA image file name.

**Syntax**

```
C/C++
RETURN_CODE
AlazarParseFPGAName (
      const char *FilePath,
      char *FileName,
      U32 *BoardType,
      U32 *MemorySizeId,
      U32 *HardwareMajorVersion,
      U32 *HardwareMinorVersion,
      U32 *FpgaMajorVersion,
      U32 *FpgaMinorVersion,
      U32 *Error
);
```

```
VisualBasic
AlazarParseFPGAName( _
      ByRef FilePath As Any, _
      ByRef FileName As Any, _
      ByRef BoardType As Long, _
      ByRef MemorySizeId As Long, _
      ByRef HardwareMajorVersion As Long, _
      ByRef HardwareMinorVersion As Long, _
      ByRef FpgaMajorVersion As Long, _
      ByRef FpgaMinorRevision As Long, _
      ByRef Error As Long _
) As Long
```

**Parameters**

*FilePath*
[in] Full path to FPGA image file.

*FileName*
[out] FPGA image file name.

*MemorySizeId*
[out] The memory size identifier of the memory in samples per channel required on the digitizer board.

*HardwareMajorVersion*
[out] Pointer to digitizer board major version number.

*HardwareMinorVersion*
[out] Pointer to digitizer board minor version number.

*FpgaMajorVersion*
[out] Pointer to FPGA major version number.

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*FpgaMinorVersion*
[out] Pointer to FPGA minor version number.

*Error*
[out] Pointer to an error code.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the path to the file path was not found, the function returns ApiFailed (513) and Error to 626.

**Remarks**

**See Also**

AlazarOEMDownLoadFPGA

### 3.2.57 AlazarPostAsyncBuffer

Add a buffer to the end of a list of buffers available to be filled by the board. Use AlazarWaitAsyncBufferComplete to determine if the board has received sufficient trigger events to fill this buffer.

**Syntax**

```
C/C++
RETURN_CODE
AlazarPostAsyncBuffer (
   HANDLE BoardHandle,
   void *Buffer,
   U32 BufferLength
);
```

```
VisualBasic
AlazarPostAsyncBuffer( _
      ByVal BoardHandle As Integer, _
      ByRef Buffer As Any, _
      ByVal BufferLength As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Buffer*

[out] Pointer to a buffer to receive sample data from the digitizer board.

*BufferLength*

[in] Specifies the length of the buffer in bytes.

**Return values**

If the function succeeds in adding the buffer to end of the list of buffers available to be filled by the board, it returns ApiSuccess (512). Use AlazarWaitAsyncBufferComplete to determine when the board has received sufficient trigger events to file this buffer.

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

You must call AlazarBeforeAsyncRead before calling **AlazarPostAsyncBuffer**.

You must call AlazarAbortAsyncRead before your application exits if you have called **AlazarPostAsyncBuffer**, and buffers are pending when your application exits.

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The BufferLength parameter must be equal to the product of the number of bytes per record, the number of records per buffer, and the number of enabled channels. If record headers are enabled, the number of bytes per record must include the size of the record header (16 bytes).

**See Also**

AlazarAbortAsyncRead
AlazarBeforeAsyncRead
Using asynchronous AutoDMA

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### 3.2.58 AlazarQueryCapability

Get a device attribute.

**Syntax**

```
C/C++
RETURN_CODE
AlazarQueryCapability (
      HANDLE BoardHandle,
      U32 Capability,
      U32 Reserved,
      U32 *Value
);
```

```
VisualBasic
AlazarQueryCapability( _
      ByVal BoardHandle As Integer, _
      ByVal Capability As Long, _
      ByVal Reserved As Long, _
      ByRef Value As Long _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*Capability*
[in] Capability identifier. See remarks below.

*Reserved*
[in] Reserved (Set to 0).

*Value*
[out] Capability value.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve value of the specified capability.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

Capability identifiers include the following items. See AlazarApi.h for a complete list of list of capability identifiers.

| Identifier | Value | Description |
|---|---|---|
| GET_SERIAL_NUMBER | 0x10000024 | Return the board serial number |

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| | | |
|---|---|---|
| GET_LATEST_CAL_DATE | 0x10000026 | Return the board's latest calibration date as a decimal number with the format DDMMYY where DD is 1-31, MM is 1-12, and YY is 00-99 from 2000. |
| GET_LATEST_CAL_DATE_MONTH | 0x1000002D | Return the month of the board's latest calibration date as a decimal number with the format MM where M is 1-12. |
| GET_LATEST_CAL_DATE_DAY | 0x1000002E | Return the day of month of the board's latest calibration date as a decimal number with the format DD where DD is 1-31. |
| GET_LATEST_CAL_DATE_YEAR | 0x1000002F | Return the year of the board's latest calibration date as a decimal number with the format YY where YY is 00-99 from 2000. |
| MEMORY_SIZE | 0x1000002A | Return the on-board memory size in maximum samples per channel in single channel mode. See AlazarGetChannelInfo for more information. |
| BOARD_TYPE | 0x1000002B | Return the board type identifier. See AlazarGetBoardKind for more information. |
| ASOPC_TYPE | 0x1000002C | Return the board's FPGA signature. |
| GET_PCIE_LINK_SPEED | 0x10000030 | Return the PCIe link speed negotiated between a PCIe digitizer board and the host PCIe bus in 2.5G bits per second units.<br><br>The PCIe bus uses 10b/8b encoding, so divide the link speed by 10 to find the link speed in bytes per second. For example, a link speed of 2.5 Gb/s gives 250 MB/s per lane.<br><br>PCIe Gen 2 digitizers such as the ATS9360 should receive |

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| | | |
|---|---|---|
| | | 5.0 Gb/s links. |
| GET_PCIE_LINK_WIDTH | 0x10000031 | Return the PCIe link width in lanes negociated between a PCIe digitizer board and the host PCIe bus.<br><br>An ATS9462 should negociate 4 lanes, while the ATS9325, ATS9350, ATS9351, ATS9360, ATS9440, ATS9850 and ATS9870 should negociate 8 lanes. If a board obtains fewer lanes, then the board may be installed in a PCIe slot that does not support the expected number of lanes.<br><br>The ideal PCIe bandwidth is the link speed in bytes per second per lane, multiplied by the link width in lanes. For example, and ATS9870 that negociates 8 lanes at 250 MB/s per lane has an ideal bandwidth of 2 GB/s. |
| GET_MAX_PRETRIGGER_SAMPLES | 0x10000046 | Get the maximum number of pre-trigger samples. |
| GET_CPF_DEVICE | 0x10000071 | Get the model of user-programable FPGA device.<br>1 = CPF_DEVICE_EP3SL50,<br>2 = CPF_DEVICE_EP3SE260 |

**See Also**

AlazarGetBoardKind
AlazarGetChannelInfo
AlazarGetParameter
AlazarGetParameterUL

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### 3.2.59 AlazarRead

Read all or part of a record from an acquisition to on-board memory from on-board memory to a buffer in host memory. The record must be less than 2,147,483,648 samples long.

**Syntax**

```
C/C++
U32
AlazarRead (
      HANDLE BoardHandle,
      U32 ChannelId,
      void *Buffer,
      int ElementSize,
      long Record,
      long TransferOffset,
      U32 TransferLength
);
```

```
VisualBasic
AlazarRead( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Long, _
      ByRef Buffer As Any, _
      ByVal ElementSize As Integer, _
      ByVal Record As Long, _
      ByVal TransferOffset As Long, _
      ByVal TransferLength As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to a board.

*ChannelId*

[out] Channel identifier of record.

*Buffer*

[out] Buffer to receive sample data.

*ElementSize*

[in] Number of bytes per sample.

*Record*

[in] Record in on-board memory to transfer to buffer (1-indexed).

*TransferOffset*

[in] The offset, in samples from the trigger position in the record, of the first sample in the record in on-board memory to transfer into the buffer.

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*TransferLength*

[in] The number of samples to transfer from the record in on-board memory into the buffer.

**Return values**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**AlazarRead** is part of the single-port data acquisition API. It cannot be used with the dual-port AutoDMA APIs.

**AlazarRead** can transfer segments of a record acquired to on-board memory. This may be useful if a full record is too large to transfer as a single block, or if only part of a record is of interest.

Use either **AlazarRead** or AlazarReadEx to transfer records with less than 2,147,483,648 samples. Use AlazarReadEx to transfer records with 2,147,483,648 or more samples.

**Examples**

The "%ATS_SDK_DIR%\Samples\SinglePort\AR" sample program demonstrates how to use **AlazarRead**.

The "%ATS_SDK_DIR%\Samples\SinglePort\AR_Segments" sample program demonstrates how to use **AlazarRead** to split records in to segments for transfer from on-board to host memory.

**See Also**

AlazarHyperDisp
AlazarGetTriggerAddress
AlazarReadEx
Using AlazarRead

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### 3.2.60 AlazarReadEx

Read all or part of a record from an acquisition to on-board memory from on-board memory to a buffer in host memory. The record may be 2,147,483,648 or more samples long.

**Syntax**

```
C/C++
U32
AlazarReadEx (
      HANDLE BoardHandle,
      U32 ChannelId,
      void *Buffer,
      int ElementSize,
      long Record,
      INT64 TransferOffset,
      U32 TransferLength
);
```

```
VisualBasic
AlazarReadEx( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Long, _
      ByRef Buffer As Any, _
      ByVal ElementSize As Integer, _
      ByVal Record As Long, _
      ByVal TransferOffset As Currency, _
      ByVal TransferLength As Long _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to a board.

*ChannelId*
[out] Channel identifier of record.

*Buffer*
[out] Buffer to receive sample data.

*ElementSize*
[in] Number of bytes per sample.

*Record*
[in] Record in on-board memory to transfer to buffer (1-indexed).

*TransferOffset*
[in] The offset, in samples from the trigger position in the record, of the first sample in the record in on-board memory to transfer into the buffer.

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*TransferLength*

[in] The number of samples to transfer from the record in on-board memory into the buffer.

**Return values**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**AlazarReadEx** is part of the single-port data acquisition API. It cannot be used with the dual-port AutoDMA APIs.

**AlazarReadEx** can transfer segments of a record acquired to on-board memory. This may be useful if a full record is too large to transfer as a single block, or if only part of a record is of interest.

Use AlazarRead or **AlazarReadEx** to transfer records with less than 2,147,483,648 samples. Use **AlazarReadEx** to transfer records with 2,147,483,648 or more samples.

**Examples**

**See Also**

AlazarRead
AlazarHyperDisp
AlazarGetTriggerAddress
Using AlazarRead

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### 3.2.61 AlazarResetTimeStamp

Control record timestamp counter resets.

**Syntax**

```
C/C++
RETURN_CODE
AlazarResetTimeStamp(
      HANDLE BoardHandle,
      U32 Option
);
```

```
VisualBasic
AlazarResetTimeStamp( _
      ByVal BoardHandle As Integer, _
      ByVal Option As Long _
) As Integer
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Option*

[in] Record timestamp counter reset options. The option can be one of the following values. See AlazarApi.h for a complete list.

| Identifier | Description |
|---|---|
| TIMESTAMP_RESET_FIRSTTIME_ONLY<br>(0) | Reset the timestamp counter to zero on the next call to AlazarStartCapture, but not thereafter. |
| TIMESTAMP_RESET_ALWAYS<br>(1) | Reset the timestamp counter to zero on each call to AlazarStartCapture. This is the default operation. |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

This function is not supported by the ATS310, ATS330, and ATS850.

**See Also**

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### 3.2.62 AlazarSetBWLimit

Control bandwidth of an input channel.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetBWLimit(
      HANDLE BoardHandle,
      U32 ChannelId,
      U32 Flag
);
```

```
VisualBasic
AlazarSetBWLimit( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Long, _
      ByVal Flag As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*ChannelId*

[in] Channel identifier.

*Flag*

[in] Enable bandwidth limit flag. The flag can be one of the following values.

| Value | Description |
|---|---|
| 0 | Disable bandwidth limit. |
| 1 | Enable bandwidth limit. |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The bandwidth limiter is disabled by default. When enabled, the bandwidth limiter reduces input bandwidth to approximately 20 MHz.

**See Also**

AlazarInputControl

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### 3.2.63 AlazarSetCaptureClock

Configure sample clock source, edge, and decimation.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetCaptureClock(
      HANDLE BoardHandle,
      U32 SourceId,
      U32 SampleRateId,
      U32 EdgeId,
      U32 Decimation
);
```

```
VisualBasic
AlazarSetCaptureClock( _
      ByVal BoardHandle As Integer, _
      ByVal SourceId As Long, _
      ByVal SampleRateId As Long, _
      ByVal EdgeId As Long, _
      ByVal Decimation As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*SourceId*

[in] ATS310/ATS330/ATS850 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| EXTERNAL_CLOCK | 2 | Use external clock signal. |

ATS460 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| FAST_EXTERNAL_CLOCK | 2 | Use 80-125 MHz external clock. |
| MEDIUM_EXTERNAL_CLOCK | 3 | Use 10-80 MHz external clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-10 MHz external clock. |

ATS660 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-10 MHz external clock. |

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| | | |
|---|---|---|
| EXTERNAL_CLOCK_AC | 5 | Use 1 K-125 MHz external clock. |
| EXTERNAL_CLOCK_DC | 6 | Use 1 K-125 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 100-130MHz sample clock in 1 MHz steps from 10MHz external clock input. |

ATS860 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| FAST_EXTERNAL_CLOCK | 2 | 20-250 MHz external clock. |
| SLOW_EXTERNAL_CLOCK | 4 | 0-250 MHz external clock. |

ATS9325 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-20 MHz external clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 1 M-250 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 500 MHz reference clock from 10MHz external clock. Use decimation to generate the sample clock from reference. |

ATS9350 / ATS9351 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-20 MHz external clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 1 M-500 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 500 MHz reference clock from 10MHz external clock. Use decimation to generate the sample clock from reference. |

ATS9360 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-900 MHz external clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 300 MHz to 1.8 GHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate any sample rate between 300 MHz and 1.8 GHz that is a multiple of 1 MHz from a 10 MHz reference. |

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ATS9440 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| FAST_EXTERNAL_CLOCK | 2 | Supply a 1MHz to125 MHz external clock signal. |
| SLOW_EXTERNAL_CLOCK | 4 | Supply a DC to 20 MHz external clock signal. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 125 MHz or 100 MHz reference clock from 10MHz external clock. Specify a decimation ratio to generate the sample clock. |

ATS9462 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-10 MHz external clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 1 M-180 MHz external clock. |
| EXTERNAL_CLOCK_DC | 6 | Use 1 M-180 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 150-180 MHz sample clock in 1 MHz steps from 10MHz external clock input. |

ATS9625/ATS9626 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 50-250 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 250 MHz internal reference from 10MHz external clock. Use decimation parameter to generate sample clock from internal reference. |

ATS9850 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 200 MHz to 500 MHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 500 MHz internal reference from 10MHz external clock. Use decimation parameter to generate sample clock from internal reference. |

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ATS9870 clock source identifiers:

| Identifier | Value | Description |
|---|---|---|
| INTERNAL_CLOCK | 1 | Use internal sample clock. |
| SLOW_EXTERNAL_CLOCK | 4 | Use 0-60 MHz external clock. |
| EXTERNAL_CLOCK_AC | 5 | Use 200 M-1 GHz external clock. |
| EXTERNAL_CLOCK_10MHz_REF | 7 | Generate 1 GHz internal reference from 10MHz external clock. Use decimation parameter to generate sample clock from internal reference. |

*SampleRateId*

[in] ATS310 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |

ATS330/ATS850 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_25MSPS | 0x00000021 | 25 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |

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ATS460 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |

ATS660 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (Sample rate value in Hz) | 100000000-130000000 | 100-130 MHz sample clock in steps of 1MHz from 10 MHz |

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| | | |
|---|---|---|
| | | PLL clock |

ATS860 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_25MSPS | 0x00000021 | 25 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |

ATS9325 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |

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| | | |
|---|---|---|
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (500 MHz reference clock) | 500000000 | 500 MHz reference clock from 10 MHz PLL external clock. Use decimation to generate sample clock from reference clock. |

ATS9350 / ATS9351 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_500MSPS | 0x00000030 | 500 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (500 MHz reference clock) | 500000000 | 500 MHz reference clock from 10 MHz PLL external clock. Use decimation to generate sample clock from reference clock. |

ATS9360 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |

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| | | |
|---|---|---|
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_500MSPS | 0x00000030 | 500 MS/s internal clock |
| SAMPLE_RATE_800MSPS | 0x00000032 | 800 MS/s internal clock |
| SAMPLE_RATE_1000MSPS | 0x00000035 | 1 GS/s internal clock |
| SAMPLE_RATE_1200MSPS | 0x00000037 | 1.2 GS/s internal clock |
| SAMPLE_RATE_1500MSPS | 0x0000003A | 1.5 GS/s internal clock |
| SAMPLE_RATE_1800MSPS | 0x0000003D | 1.8 GS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (Sample rate value in Hz) | 300,000,000 to 1,800,000,000 | Sample rate to generate from 10 MHz reference. Sample rate must be a multiple of 1 MHz. |

ATS9440 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (10 MHz reference clock) | 125,000,000 or 100,000,000 | 125 MHz or 100 MHz reference clock from 10 MHz PLL external clock. Specify a |

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| | | |
|---|---|---|
| | | decimation ratio to generate a sample clock from the reference clock. |

ATS9462 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_160MSPS | 0x00000026 | 160 MS/s internal clock |
| SAMPLE_RATE_180MSPS | 0x00000027 | 180 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (Sample rate value in Hz) | 150000000-180000000 | 150-180 MHz in steps of 1 MHz sample clock from 10 MHz PLL external clock |

ATS9625 / ATS9626 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |

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| | | |
|---|---|---|
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_125MSPS | 0x00000025 | 125 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (250 MHz reference clock) | 250000000 | 250 MHz reference clock from 10 MHz PLL external clock. Use decimation to generate sample clock from reference clock. |

ATS9850 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_500MSPS | 0x00000030 | 500 MS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (500 MHz reference clock value) | 500000000 | 500 MHz reference clock from 10 MHz PLL external clock. Use decimation to generate sample clock from reference clock. |

ATS9870 sample rate identifiers:

| Identifier | Value | Description |
|---|---|---|
| SAMPLE_RATE_1KSPS | 0x00000001 | 1 KS/s internal clock |
| SAMPLE_RATE_2KSPS | 0x00000002 | 2 KS/s internal clock |
| SAMPLE_RATE_5KSPS | 0x00000004 | 5KS/s internal clock |
| SAMPLE_RATE_10KSPS | 0x00000008 | 10 KS/s internal clock |

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| | | |
|---|---|---|
| SAMPLE_RATE_20KSPS | 0x0000000A | 20 KS/s internal clock |
| SAMPLE_RATE_50KSPS | 0x0000000C | 50 KS/s internal clock |
| SAMPLE_RATE_100KSPS | 0x0000000E | 100 KS/s internal clock |
| SAMPLE_RATE_200KSPS | 0x00000010 | 200 KS/s internal clock |
| SAMPLE_RATE_500KSPS | 0x00000012 | 500 KS/s internal clock |
| SAMPLE_RATE_1MSPS | 0x00000014 | 1 MS/s internal clock |
| SAMPLE_RATE_2MSPS | 0x00000018 | 2 MS/s internal clock |
| SAMPLE_RATE_5MSPS | 0x0000001A | 5 MS/s internal clock |
| SAMPLE_RATE_10MSPS | 0x0000001C | 10 MS/s internal clock |
| SAMPLE_RATE_20MSPS | 0x0000001E | 20 MS/s internal clock |
| SAMPLE_RATE_50MSPS | 0x00000022 | 50 MS/s internal clock |
| SAMPLE_RATE_100MSPS | 0x00000024 | 100 MS/s internal clock |
| SAMPLE_RATE_250MSPS | 0x0000002B | 250 MS/s internal clock |
| SAMPLE_RATE_500MSPS | 0x00000030 | 500 MS/s internal clock |
| SAMPLE_RATE_1GSPS | 0x00000035 | 1 GS/s internal clock |
| SAMPLE_RATE_USER_DEF | 0x00000040 | External clock. |
| (1GHz reference clock value) | 1000000000 | 1GHz reference clock from 10 MHz PLL external clock. Use decimation to generate sample clock from reference clock. |

*EdgeId*

[in] Select the external clock edge on which to latch samples data. The clock edge identifier may be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| CLOCK_EDGE_RISING | 0 | Sample on rising edge of external clock. |
| CLOCK_EDGE_FALLING | 1 | Sample on falling edge of external clock. |

*Decimation*

[in] Clock decimation value. See the remarks below.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The clock decimation value may be any integer between 0 and 100000 with the following exceptions. Note that a decimation value of 0 means disable decimation.

- If an ATS460/ATS660/ATS860 is configured to use a SLOW_EXTERNAL_CLOCK clock source, the maximum decimation value is 1.

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- If an ATS9350 is configured to use an EXTERNAL_CLOCK_10MHz_REF clock source, the decimation value must be 1, 2, 4 or any multiple of 5. Note that the sample rate identifier value must be 500000000, and the sample rate will be 500 MHz divided by the decimation value.

- If an ATS9360 is configure to use an EXTERNAL_CLOCK_10MHz_REF clock source, the maximum decimation value is 1.

- If an ATS9850 is configured to use an EXTERNAL_CLOCK_10MHz_REF clock source, the decimation value must be 1, 2, 4 or any multiple of 10. Note that the sample rate identifier value must be 500000000, and the sample rate will be 500 MHz divided by the decimation value.

- If an ATS9870 is configured to use an EXTERNAL_CLOCK_10MHz_REF clock source, the decimation value must be 1, 2, 4 or any multiple of 10. Note that the sample rate identifier value must be 1000000000, and the sample rate will be 1 GHz divided by the decimation value.

**See Also**

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### 3.2.64 AlazarSetClockSwitchOver

Configure the dummy clock.

When the "dummy clock" option enabled, the digitizer uses an internally generated clock signal to drive its ADCs for a specified amount of time after the end of each record. At the end of the dummy clock on time, the digitizer switches back to using the external clock signal to clock the ADCs.

Scanning applications that generate an unusable external clock signal during horizontal retrace periods at the end of each scan line should consider enabling the "dummy clock" option.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetClockSwitchOver(
      HANDLE hBoard,
      U32    Mode,
      U32    DummyClockOnTime_ns,
      U32    Reserved
      )
```

```
VisualBasic
RETURN_CODE
AlazarSetClockSwitchOver( _
      ByVal BoardHandle As Integer, _
      ByVal Mode As Long, _
      ByVal DummyClockOnTime_ns As Long, _
      ByVal Reserved As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Mode*

[in] Clock switch over mode. The parameter can be one of the following values:

| Name | Value | Description |
|---|---|---|
| CSO_DISABLE | 0 | Disable clock switch over. |
| CSO_ENABLE_DUMMY_CLOCK | 1 | Enable dummy clock mode. |

*DummyClockOnTime_ns*

[in] Dummy clock on-time in nanoseconds.

If dummy clock mode is enabled, the digitizer switches to an internally generated dummy clock after capturing each record, and uses the dummy clock for this

amount of time. After the dummy clock on-time period has expired, the digitizer switches back to using an external clock signal.

*Reserved*
[in] Not used.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the feature is not implemented in firmware, the function returns ApiUnsupportedFunction. Please contact AlazarTech for updated firmware.

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The dummy clock on-time should be selected so that it is longer than the amount time that external clock signal is unstable, but must not be longer than the time between the end of one record, and the start of the next record.

The dummy clock feature is implemented in the ATS9351, ATS9440, ATS9625, ATS9626, and ATS9350 with firmware version 14.10 or later.

**See Also**

AlazarSetCaptureClock

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### 3.2.65 AlazarSetExternalClockLevel

Set the external clock comparator level.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetExternalClockLevel(
      HANDLE BoardHandle,
      float Level_percent
);
```

```
VisualBasic
AlazarSetExternalClockLevel( _
      ByVal BoardHandle As Integer, _
      ByVal Level_percent As Single  _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Level_percent*

[in] The external clock comparator level, in percent.

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

Note that the function fails with error code ApiUnsupportedFunction (533) if the digitizer does not support setting the external clock comparator level. The following table lists the boards that support this feature.

| Model | Supported |
|---|---|
| ATS310, ATS330, ATS460, ATS850, ATS860, ATS9440 | No |
| ATS660, ATS9325, ATS9350, ATS9351, ATS9360, ATS9462,<br>ATS9625, ATS9626, ATS9850, ATS9870 | Yes |

**Remarks**

**See Also**

AlazarSetCaptureClock

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### 3.2.66 AlazarSetExternalTrigger

Set the external trigger range and coupling.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetExternalTrigger (
      HANDLE BoardHandle,
      U32 CouplingId,
      U32 RangeId
);
```

```
VisualBasic
AlazarSetExternalTrigger( _
      ByVal BoardHandle As Integer, _
      ByVal CouplingId As Long, _
      ByVal RangeId As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*CouplingId*

[in] Specifies the external trigger coupling. This parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| AC_COUPLING | 1 | AC coupled trigger input |
| DC_COUPLING | 2 | DC coupled trigger input |

*RangeId*

[in] Specifies the external trigger range. This parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| ETR_5V | 0 | ±5V external trigger range. |
| ETR_1V | 1 | ±1V external trigger range. |
| ETR_TTL | 2 | TTL level external trigger range |
| ETR_2V5 | 3 | ±2.5V external trigger range |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

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**Remarks**

**See Also**

AlazarSetTriggerDelay
AlazarSetTriggerOperation
AlazarSetTriggerTimeOut

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### 3.2.67 AlazarSetLED

Control LED on a board's PCI/PCIe mounting bracket.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetLED (
      HANDLE BoardHandle,
      U32 LedOn
);
```

```
VisualBasic
AlazarSetLED( _
      ByVal BoardHandle As Integer, _
      ByVal LedOn as Integer _
) As Integer
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*LedOn*

[in] Specify LED state. This parameter may have one of the following values.

| Identifier | Value | Description |
|---|---|---|
| LED_OFF | 0 | Turn off LED |
| LED_ON | 1 | Turn on LED |

**Return value**

If the function succeeds, it returns ApiSuccess (512).

If the function fails, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

See the "%ATS_SDK_DIR%\Samples\AlazarSysInfo" for a sample program that controls the LED.

**See Also**

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### 3.2.68 AlazarSetParameter

Set a device parameter as a signed long value.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetParameter(
      HANDLE BoardHandle,
      U8 ChannelId
      U32 ParameterId,
      long Value
);
```

```
VisualBasic
AlazarSetParameter( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Byte, _
      ByVal ParameterId As Long, _
      ByVal Value As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*ChannelId*

[in] The channel to control.

This channel identifier may be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| CHANNEL_A | 1 | Apply parameter to CH A |
| CHANNEL_B | 2 | Apply parameter to CH B |
| CHANNEL_C | 4 | Apply parameter to CH C |
| CHANNEL_D | 8 | Apply parameter to CH D |
| 0 | 0 | The parameter does not apply to a channel |

*ParameterId*

[in] Parameter to modify.

The parameter identifier may be one of the following values. See AlazarApi.h for a complete list of list of parameter identifiers.

| Identifier | Value | Description |
|---|---|---|
| SETGET_ASYNC_BUFFCOUNT | 0x10000040 | Select number of API allocated DMA buffers. |
| SET_DATA_FORMAT | 0x10000041 | Select sample data format: 0 = unsigned , 1 = signed. |
| ECC_MODE | 0x1000004 | Set EEC mode: 0 = disable, 1 |

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| | | |
|---|---|---|
| | 8 | = enable. |

*Value*

[in] Parameter value.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**See Also**

AlazarGetParameter
AlazarGetParameterUL
AlazarSetParameterUL

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### 3.2.69 AlazarSetParameterUL

Set a device parameter as an unsigned 32-bit value.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetParameterUL (
      HANDLE BoardHandle,
      U8 ChannelId
      U32 ParameterId,
      U32 Value
);
```

```
VisualBasic
AlazarSetParameterUL( _
      ByVal BoardHandle As Integer, _
      ByVal ChannelId As Byte, _
      ByVal ParameterId As Long, _
      ByVal Value As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*ChannelId*

[in] The channel to control.

This channel identifier may be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| CHANNEL_ALL | 0 | The parameter applys to all channels |
| CHANNEL_A | 1 | Apply parameter to CH A |
| CHANNEL_B | 2 | Apply parameter to CH B |
| CHANNEL_C | 4 | Apply parameter to CH C |
| CHANNEL_D | 8 | Apply parameter to CH D |

*ParameterId*

[in] Parameter to modify.

*Value*

[in] Parameter value.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

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Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

See AlazarApi.h for a list of parameter identifiers.

**See Also**

AlazarGetParameter
AlazarGetParameterUL
AlazarSetParameter

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### 3.2.70 AlazarSetRecordCount

Select the number of records to capture to on-board memory.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetRecordCount (
      HANDLE BoardHandle,
      U32 RecordsPerCapture
);
```

```
VisualBasic
AlazarSetRecordCount( _
      ByVal BoardHandle As Integer, _
      ByVal RecordsPerCapture As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*RecordsPerCapture*

[in] The number of records to acquire to on-board memory during the acquisition.

**Return value**

The function returns ApiSuccess (512) if it was successful.

The function returns 607 if the number of records is greater than greater than the maximum number supported by the firmware revision.

Otherwise, the function returns an error code indicating the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

This function is part of the single-port API. It cannot be used with the dual-port AutoDMA functions.

The maximum number of records per capture is a function of the board type, the maximum number of samples per channel ($SPC_{max}$), and the current number of samples per record (SPR):

| Board type | Maximum records per capture |
|---|---|
| ATS850, ATS310, ATS330 | $SPC_{max}$ / (SPR + 16) or 10000, whichever is smaller. |
| ATS460, ATS660, ATS9462 | $SPC_{max}$ / (SPR + 16) or 256000 records, whichever is smaller. |

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| | |
|---|---|
| ATS860, ATS9325, ATS9350, ATS9351 | $SPC_{max}$ / (SPR + 32) or 256000 records, whichever is smaller. |
| ATS9850, ATS9870 | $SPC_{max}$ / (SPR + 64) or 256000 records, whichever is smaller. |

**See Also**

AlazarRead
AlazarHyperDisp
AlazarGetTriggerAddress

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### 3.2.71 AlazarSetRecordSize

Set the number of pre- and post-trigger samples per record.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetRecordSize(
      HANDLE BoardHandle,
      U32 PreTriggerSamples,
      U32 PostTriggerSamples
);
```

```
VisualBasic
AlazarSetRecordSize( _
      ByVal BoardHandle As Integer, _
      ByVal PreTriggerSamples As Long, _
      ByVal PostTriggerSamples As Long _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*PreTriggerSamples*
[in] The number of samples before the trigger position in each record.

*PostTriggerSamples*
[in] The number of samples at or after the trigger position in each record.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The number of pre-trigger samples must not exceed the number of samples per record minus 64.

The number of samples per record is the sum of the pre- and post-trigger samples. The number of samples per record has the following requirements.

| Board type | Minimum (samples) | Alignment (samples) |
|---|---|---|
| ATS310 | 256 | 16 |

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| | | |
|---|---|---|
| ATS330 | 256 | 16 |
| ATS850 | 256 | 4 |

The number of samples per transfer is the number of samples per record multiplied by the number of records per transfer in dual-port mode using AutoDMA.

| Board type | Minimum (samples) | Alignment (samples) | Alignment in NPT mode (samples) |
|---|---|---|---|
| ATS460 | 128 | 16 | 32 |
| ATS660 | 128 | 16 | 32 |
| ATS860 | 256 | 32 | 64 |
| ATS9462 | 256 | 32 | 32 |
| ATS9325 | 256 | 32 | 32 |
| ATS9350 | 256 | 32 | 32 |
| ATS9351 | 256 | 32 | 32 |
| ATS9360 | 256 | 32 | 32 |
| ATS9625 | 256 | 32 | 32 |
| ATS9626 | 256 | 32 | 32 |
| ATS9850 | 256 | 64 | 64 |
| ATS9870 | 256 | 64 | 64 |
| ATS9440 | 256 | 32 | 32 |

**See Also**

AlazarBeforeAsyncRead
AlazarRead
AlazarStartAutoDMA

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### 3.2.72 AlazarSetTriggerDelay

Set the time, in sample clocks, to wait after receiving a trigger event before capturing a record for the trigger.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetTriggerDelay (
      HANDLE BoardHandle,
      U32 Value
);
```

```
VisualBasic
AlazarSetTriggerDelay( _
      ByVal BoardHandle As Integer, _
      ByVal Value As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Value*

[in] Trigger delay in sample clocks.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

To convert the trigger delay from seconds to sample clocks, multiple the sample rate in samples per second by the trigger delay in seconds. For example, if the sample rate is 50 MS/s and the desired trigger delay is 1 ms, then the trigger delay in sample clocks is 50e6 samples per second x 1e-3 seconds = 50000 samples.

The trigger delay value may be 0 to 9,999,999 samples.

The trigger delay value must be a multiple of 4 for the ATS850 and ATS860.

The minimum trigger delay for the ATS9350 and ATS9360 is 16 samples in single channel mode, or 8 samples in dual channel mode.

**See Also**

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AlazarSetExternalTrigger
AlazarSetTriggerOperation
AlazarSetTriggerTimeOut

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### 3.2.73 AlazarSetTriggerOperation

Configure the trigger system.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetTriggerOperation (
      HANDLE BoardHandle,
      U32 TriggerOperation,
      U32 TriggerEngineId1,
      U32 SourceId1,
      U32 SlopeId1,
      U32 Level1,
      U32 TriggerEngineId2,
      U32 SourceId2,
      U32 SlopeId2,
      U32 Level2
);
```

```
VisualBasic
AlazarSetTriggerOperation( _
      ByVal BoardHandle As Integer, _
      ByVal TriggerOperation As Long, _
      ByVal TriggerEngineId1 As Long, _
      ByVal SourceId1 As Long, _
      ByVal SlopeId1 As Long, _
      ByVal Level1 As Long, _
      ByVal TriggerEngineId2 As Long, _
      ByVal SourceId2 As Long, _
      ByVal SlopeId2 As Long, _
      ByVal Level2 As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*TriggerOperation*

[in] Specify how the two independent trigger engines generate a trigger event.

This parameter can be one of the following values.

| Identifier | Value | Meaning<br>Generate a trigger event when… |
|---|---|---|
| TRIG_ENGINE_OP_J | 0 | $T_j$ goes low to high. |
| TRIG_ENGINE_OP_K | 1 | $T_k$ goes low to high. |
| TRIG_ENGINE_OP_J_OR_K | 2 | $T_j$ goes low to high, or $T_k$ goes low to high. |
| TRIG_ENGINE_OP_J_AND_K | 3 | ($T_j$ AND $T_{k)}$ goes low to high. |
| TRIG_ENGINE_OP_J_XOR_K | 4 | ($T_j$ XOR $T_{k)}$ goes low to high. |

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| | | |
|---|---|---|
| TRIG_ENGINE_OP_J_AND_NOT_K | 5 | ($T_j$ AND (NOT $T_k$)) goes low to high. |
| TRIG_ENGINE_OP_NOT_J_AND_K | 6 | ((NOT $T_j$)AND $T_k$) goes low to high. |

Note that the symbol $T_j$ represents the output of trigger engine J, and $T_k$ represents the output of trigger engine K.

*TriggerEngineId1*
*TriggerEngineId2*

[in] Select the trigger engine to configure

This parameter can be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIG_ENGINE_J | 0 | Configure trigger engine J |
| TRIG_ENGINE_K | 1 | Configure trigger engine K |

*SourceId1*
*SourceId2*

[in] Select the signal source for the specified trigger engine.

This parameter can be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIG_CHAN_A | 0 | Use signals from CH A |
| TRIG_CHAN_B | 1 | Use signals from CH B |
| TRIG_EXTERNAL | 2 | Use signals from the TRIG IN input |
| TRIG_DISABLE | 3 | Disable this trigger engine. |
| TRIG_CHAN_C | 4 | Use signals from CH C |
| TRIG_CHAN_D | 5 | Use signals from CH D |

*SlopeId1*
*SlopeId2*

[in] Select the sign of the rate of change of the trigger signal with time when it crosses the trigger voltage level that is required to generate a trigger event.

This parameter can be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIGGER_SLOPE_POSITIVE | 1 | The trigger engine output goes from low to high when sample values from the trigger source rise above a specified level. |
| TRIGGER_SLOPE_NEGATIVE | 2 | The trigger engine output goes from low to high when sample values from the trigger source fall below a specified level. |

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*Level1*
*Level2*

[in] Select the voltage level that the trigger source signal for the specified trigger engine must pass through to generate a trigger event. See the remarks below.

**Return value**

The function returns ApiSuccess (512) if succeeds.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The trigger level is specified as an unsigned 8-bit code that represents a fraction of the full scale input voltage of the trigger source: 0 represents the negative limit, 128 represents the 0 level, and 255 represents the positive limit.

For example, if the trigger source is CH A, and the CH A input range is ± 800 mV, then 0 represents a –800 mV trigger level, 128 represents a 0 V trigger level, and 255 represents +800 mV trigger level.

In general, the trigger level code is given by:

```
TriggerLevelCode = 128 + 127 * TriggerLevelVolts / InputRangeVolts.
```

Note that AlazarSetExternalTrigger is used to select the trigger input range if the trigger source is an external trigger signal connected to the TRIG IN connector.

**See Also**

Trigger control
AlazarSetTriggerDelay
AlazarSetExternalTrigger
AlazarSetTriggerTimeOut
AlazarSetTriggerOperationForScanning

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### 3.2.74 AlazarSetTriggerOperationForScanning

Configure the trigger engines of a board to use an external trigger input and, optionally, synchronize the start of an acquisition with the next external trigger event after AlazarStartCapture is called.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetTriggerOperationForScanning (
      HANDLE BoardHandle,
      U32 TriggerSlopeId,
      U32 TriggerLevel,
      U32 Options
);
```

```
VisualBasic
AlazarSetTriggerOperation( _
      ByVal BoardHandle As Integer, _
      ByVal SlopeId As Long, _
      ByVal Level As Long, _
      ByVal Options As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*SlopeId*

[in] Select the direction of the rate of change of the external trigger signal when it crosses the trigger voltage level that is required to generate a trigger event.

This parameter can be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| TRIGGER_SLOPE_POSITIVE | 1 | Generate a trigger event when the external trigger level rises above a specified level. |
| TRIGGER_SLOPE_NEGATIVE | 2 | Generate a trigger event when the exernal trigger level falls below a specified level. |

*Level*

[in] Specify a trigger level code representing the trigger level in volts that an external trigger signal connected must pass through to generate a trigger event. See the Remarks section below.

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*Optionsl*

[in] The options parameter may be one of the following flags

| Identifier | Meaning |
|---|---|
| STOS_OPTION_DEFER_START_CAPTURE (0x00000001) | Wait until the next external trigger event after the application calls AlazarStartCapture before arming the board to start the acquisition. The external clock input should be valid when the trigger event arrives. |

**Return value**

The function returns ApiSuccess (512) if succeeds.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

**AlazarSetTriggerOperationForScanning** is intended for scanning applications that supply both external clock and external trigger signals to the digitizer, where the external clock is not suitable to drive the digitizer in between trigger events.

This function configures a board to use trigger operation TRIG_ENGINE_OP_J, and the source of TRIG_ENGINE_J to be TRIG_EXTERNAL. The application must call AlazarSetExternalTrigger to set the full-scale external input range and coupling of the external trigger signal connected to the TRIG IN connector. An application should call **AlazarSetTriggerOperationForScanning** or AlazarSetTriggerOperation, but not both.

The trigger level is specified as an unsigned 8-bit code that represents a fraction of the full scale input voltage of the external trigger range: 0 represents the negative limit, 128 represents the 0 level, and 255 represents the positive limit.

**AlazarSetTriggerOperationForScanning** in currently only supported on ATS9462 with FPGA 35.0 or later.

**See Also**

Trigger control
AlazarSetTriggerDelay
AlazarSetTriggerOperation
AlazarSetExternalTrigger
AlazarSetTriggerTimeOut

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### 3.2.75 AlazarSetTriggerTimeOut

Set the time to wait for a trigger event before automatically generating a trigger event.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSetTriggerTimeOut(
      HANDLE BoardHandle,
      U32 TimeoutTicks
);
```

```
VisualBasic
AlazarSetTriggerTimeOut( _
      ByVal BoardHandle As Integer, _
      ByVal TimeoutTicks As Long _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

*TimeoutTicks*
[in] Trigger timeout in 10 µs units, or 0 to wait forever for a trigger event.

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

To convert the trigger timeout from seconds to trigger timeout ticks, multiply the timeout value in seconds by 1e5.

For example, a trigger timeout of 1 ms is equal to 1e-3 * 1e5 = 100 ticks.

**See Also**

Trigger control
AlazarSetExternalTrigger
AlazarSetTriggerDelay
AlazarSetTriggerOperation

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### 3.2.76 AlazarSleepDevice

Control power to ADC devices.

**Syntax**

```
C/C++
RETURN_CODE
AlazarSleepDevice(
      HANDLE BoardHandle,
      U32 SleepState
);
```

```
VisualBasic
AlazarSleepDevice( _
      ByVal BoardHandle As Integer, _
      ByVal SleepState As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*SleepState*

[in] Specify power state of ADC converters.

This parameter can be one of the following values.

| Identifier | Value | Description |
|---|---|---|
| POWER_OFF | 0 | Turn off power to ADC devices. |
| POWER_ON | 1 | Turn on power to ADC devices |

**Return value**

The function returns ApiSuccess (512) if it was able to retrieve the value of the specified parameter.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

The API automatically powers up all devices when it loads.

**See Also**

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### 3.2.77 AlazarStartAutoDMA

**This function is deprecated. Do not use in new designs.**

This routine is used to enable the AUTODMA functionalities of the device. It must be called prior to calling AlazarGetNextBuffer(...).

**Syntax**

C/C++

```
RETURN_CODE
AlazarStartAutoDMA(
      HANDLE h,
      void* Buffer1,
      U32 UseHeader,
      U32 ChannelSelect,
      long TransferOffset,
      U32 TransferLength,
      U32 RecordsPerBuffer,
      U32 RecordCount,
      AUTODMA_STATUS* error,
      U32 cFlags,
      U32 r2,
      U32 *r3,
      U32 *r4
);
```

VisualBasic

```
AlazarStartAutoDMA( _
      ByVal h As Integer, _
      ByRef Buffer1 As Any, _
      ByVal UseHeader As Long, _
      ByVal ChannelSelect As Long, _
      ByVal TransferOffset As Integer, _
      ByVal TransferLength As Long, _
      ByVal RecordsPerBuffer As Long, _
      ByVal RecordCount As Long, _
      ByRef error As Long, _
      ByVal cFlags As Long, _
      ByVal r2 As Long, _
      ByRef r3 As Long, _
      ByRef r4 As Long _
) As Long
```

**Parameters**

*h*

[in] Handle to the device.

*Buffer1*

[out] Data buffer for the first set of transferred records. Buffer1 should be large enough to contain (RecordsPerBuffer*TransferLength) many 16-bit values (VB-Integer, C&C++-short).

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If the Record header is selected (UseHeader = 1) then Buffer1 should be large enough to hold (RecordsPerBuffer*(TransferLength+sizeof(ALAZAR_HEADER)) many 16bit values.

*UseHeader*

[in] If equal to 1 then the AUTODMA record header will precede each record in the Buffer

*ChannelSelect*

[in] This parameter may be one of the following identifiers or values.

| Identifier | Value | Meaning |
|---|---|---|
| CHANNEL_A | 1 | Single channel mode |
| CHANNEL_B | 2 | Single channel mode |
| CHANNEL_A \| CHANNEL_B | 3 | Dual channel mode |

*TransferOffset*

[in] Transfer offset relative to the Trigger point for each record.

*TransferLength*

[in] The amount to transfer for each record.

*RecordsPerBuffer*

[in] The number of records that will be transferred into Buffer1. (Please note the size information in Buffer1 description).

*RecordCount*

[in] The number of records to be captured during this acquisition. Infinite Record Count can be used to create an endless capture for any AutoDMA mode. To use Inifinite records, set the RecordCount parameter of AlazarStartAutoDMA(…) to 0x7FFFFFFF. It is the user's responsibility to set the criteria for stopping an acquisition. Note that AlazarStartAutoDMA routine will overwrite any previous settings for this parameter with the value passed in the RecordCount parameter (Please note the size information in Buffer1 description).

*Error*

[out] Error return code.

This error code may be one of the following values.

| Identifier | Value | Meaning |
|---|---|---|
| ADMA_Completed | 0 | No errors occurred |
| ADMA_Success | 0 | No errors occurred |
| ADMA_Buffer1Invalid | 1 | Buffer1 is not a suitable buffer |
| ADMA_Buffer2Invalid | 2 | Buffer2 is not a suitable buffer |
| ADMA_BoardHandleInvalid | 3 | Board handle is not valid |
| ADMA_InternalBuffer1Invalid | 4 | The routine cannot allocate enough memory because system resources are low |
| ADMA_InternalBuffer2Invalid | 5 | The routine cannot allocate enough |

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| | | |
|---|---|---|
| | | memory because system resources are low |
| ADMA_OverFlow | 6 | A hardware overflow occurred |
| ADMA_InvalidChannel | 7 | The channel selected is invalid |
| ADMA_DMAInProgress | 8 | A memory transfer is in progress |
| ADMA_UseHeaderNotSet | 9 | UseHeader must be set |
| ADMA_HeaderNotValid | 10 | An invalid header was encountered |
| ADMA_InvalidRecsPerBuffer | 11 | RecordCount must be a perfect multiple of RecsPerBuffer |

*cFlags*

[in] Control Flags,{0 = The routine will automatically start the acquisition, 1 = The user application must call AlazarStartCapture to start the acquisition}. The constants available are as follows:

| Identifier | Meaning |
|---|---|
| ADMA_EXTERNAL_STARTCAPTURE 0x00000001 | The User must call AlazarStartCapture to start the acquisition |
| ADMA_TRADITIONAL_MODE 0x00000000 | Traditional Auto Dma mode captures |
| ADMA_CONTINUOUS_MODE 0x00000100 | Continuous Streaming mode without trigger |
| ADMA_NPT 0x00000200 | No-Pre-Trigger Auto Dma mode |

*r2*

[in] RESERVED.

*r3*

[out] RESERVED.

*r4*

[out] RESERVED.

**Return value**

See Table 2 for a list of error codes.

**Remarks**

The user must ensure that Buffer1 is a valid buffer of the appropriate size.

Buffer1 should be large enough to contain (RecordsPerBuffer*TransferLength) many 16-bit values (VB-Integer, C&C++-short).
If the Record header is selected (UseHeader = 1) then Buffer1 should be large enough to hold (RecordsPerBuffer*(TransferLength+sizeof(ALAZAR_HEADER)) many 16bit values.

**See Also**

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AlazarAbortAutoDma
AlazarGetNextAutoDMABuffer
Using synchronous AutoDMA

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### 3.2.78 AlazarStartCapture

Arm a board to start an acquisition.

**Syntax**

```
C/C++
RETURN_CODE
AlazarStartCapture(
      HANDLE BoardHandle,
);
```

```
VisualBasic
AlazarStartCapture( _
      ByVal BoardHandle As Integer, _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

The function returns ApiSuccess (512) if the function completes without error.

The function returns ApiError (603) if the requested number of records in a single-port acquisition exceeds the maximum supported by the digitizer. See remarks below.

Otherwise, the function returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

Only call **AlazarStartCapture** on the master board in a master slave board system.

PCIe digitizers support up to 1000 records per acquisition in single-port acquisition mode. Use dual-port AutoDMA acquisition mode to capture more than 1000 records per acquisition. Dual-port AutoDMA acquisitions support an unlimited number of records per acquisition.

**See Also**

AlazarBeforeAsyncRead
AlazarStartAutoDMA

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### 3.2.79 AlazarStopAutoDMA

**This function is deprecated. Do not use in new designs.**

This API is used to inhibit the software from issuing any new DMA request to the device. It is meant as a helper function for the AlazarFlushAutoDMA API function.

#### Syntax

```
C/C++
Void AlazarStopAutoDMA(HANDLE h);
```

```
VisualBasic
AlazarStopAutoDMA(ByVal h As Integer)
```

#### Parameters

*h*

[in] Handle to board.

#### Return value

None

#### Remarks

This function is useful in situations where the application software has multiple threads. The software can call this routine to stop the device from issuing DMA requests in preparation for calling API AlazarFlushAutoDMA.

#### See Also

AlazarFlushAutoDMA
Using synchronous AutoDMA

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### 3.2.80 AlazarTriggered

Determine if a board has triggered during the current acquisition.

**Syntax**

```
C/C++
U32 AlazarTriggered (
      HANDLE BoardHandle
);
```

```
VisualBasic
AlazarTriggered( _
      ByVal BoardHandle As Integer _
) As Long
```

**Parameters**

*BoardHandle*
[in] Handle to board.

**Return value**

If the board has received at least one trigger event since the last call to AlazarStartCapture, this function returns 1.

Otherwise, this function returns 0.

**Remarks**

**See Also**

AlazarStartCapture

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### 3.2.81 AlazarWaitAsyncBufferComplete

This function returns when a board has received sufficient triggers to fill the specified buffer, or the timeout interval elapses.

**Syntax**

```
C/C++
RETURN_CODE
AlazarWaitAsyncBufferComplete(
   HANDLE  BoardHandle,
   void *Buffer,
   U32 Timeout_ms
   );
```

```
VisualBasic
AlazarWaitAsyncBufferComplete( _
      ByVal h As Integer, _
      ByRef Buffer As Any, _
      ByVal Timeout_ms As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Buffer*

[out] Pointer to a buffer to receive sample data from the digitizer board.

*Timeout_ms*

[in] Specify the time to wait, in milliseconds, for the buffer to be filled.

**Return values**

If the board receives sufficient trigger events to fill this buffer before the timeout interval elapses, the function returns ApiSuccess (512).

If the timeout interval elapses before the board receives sufficient trigger events to fill the buffer, the function returns ApiWaitTimeout (579).

If the board overflows its on-board memory, the function returns ApiBufferOverflow (582). The board may overflow its on-board memory because the rate at which it is acquiring data is faster than the rate at which the data is being transferred from on-board memory to host memory across the host bus interface (PCI or PCIe). If this is the case, try reducing the sample rate, number of enabled channels, or amount of time spent processing each buffer.

If this buffer was not found in the listof buffers available to be filled by the board, the function returns ApiBufferNotReady (573).

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If this buffer is not the buffer at the head of the list of buffers to be filled by the board, this returns ApiDmaInProgress (518).

If the function fails for some other reason, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

You must call AlazarBeforeAsyncRead and AlazarPostAsyncBuffer before calling **AlazarWaitAsyncBufferComplete**.

You must call AlazarAbortAsyncRead before your application exits if you have called AlazarPostAsyncBuffer, and buffers are pending when you wish to exit your application.

Each call to AlazarPostAsyncBuffer adds a buffer to end of a list of buffers to be filled by the board. **AlazarWaitAsyncBufferComplete** expects to wait on the buffer at the head of the list of buffers available to be filled by the board. As a result, you must wait for buffers in the same order that they were posted.

When **AlazarWaitAsyncBufferComplete** returns ApiSuccess (512), the buffer is removed from the list of buffers to be filled by the board.

The arrangement of sample data in each buffer depends on the AutoDMA mode specified in the call to AlazarBeforeAsyncRead.

**See Also**

AlazarAbortAsyncRead
AlazarBeforeAsyncRead
AlazarPostAsyncBuffer
Using asynchronous AutoDMA

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### 3.2.82 AlazarWaitForBufferReady

**This function is deprecated. Do not use in new designs.**

This function will stall the current thread of execution for tms number milliseconds or until a buffer has been successfully transferred to a user space AutoDMA buffer. The function must be called after API AlazarEvents(h,1) and before API AlazarGetNextAutoDMABuffer(…). It will wait on the driver to signal the Driver's Internal registered event for up to tms number of milliseconds. When the DMA completes, the signaling event will wake up the Api.

**Syntax**

```
C/C++
RETURN_CODE
AlazarWaitForBufferReady(
      HANDLE h,
      U32 tms
);
```

```
VisualBasic
AlazarWaitForBufferReady( _
      ByVal h As Integer, _
      ByVal tms As Long, _
) As Long
```

**Parameters**

*h*

[in] Handle to the device.

*tms*

[in] time in milliseconds

**Return values**

670 - signifies that a NULL was used for the handle

671 - signifies that the current device driver does not support events.

672 – Events were not activated using API AlazarEvents.

ApiSuccessFul or 512 signifies that the internal wait event was successfully registered and signaled by the ISR.

ApiFailed or 513 signifies that the internal wait event did not register.

ApiWaitTimeOut or 579 signifies that the internal wait event was not signaled by the ISR.

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**Remarks**

This functionality is only present on the ATS460, ATS660 and ATSS860 devices.
If AlazarEvents(h,1) was not used, calling AlazarWaitForBuffer(...) will return ApiFailed and will not disrupt any ongoing signal captures.

Below is a pseudo-code fragment that shows the operations of API AlazarEvents(…) and API AlazarWaitForBufferReady(…).

Pseudo-code:

```
AlazarSetRecordSize(...);
AlazarSetCaptureClock(...);
AlazarInputControl(...);
AlazarInputControl(...);
AlazarSetTriggerOperation(...)
//
AlazarEvents(h,1);
//
AlazarStartAutoDMA(...);
while (looping == 1)
{
      AlazarWaitForBufferReady(h, 10);
      status = AlazarGetNextAutoDMABuffer();
      if (status == 513)
      {
            looping = 0;
      }
      //Valid data exists in either UserData[0] or UserData[1]
      if ((WhichOne == 0)||(WhichOne == 1))
      {
            //Process Your Data here
            ...
      }
      if (error == ADMA_OverFlow)
      {
            looping = 0;
            returnValue = -4;
      }

}
AlazarCloseAUTODma(...);
//
AlazarEvents(h,0);
//
```

**See Also**

AlazarEvents
Using synchronous AutoDMA

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### 3.2.83 AlazarWaitNextAsyncBufferComplete

This function returns when the board has received sufficient trigger events to fill the buffer, or the timeout interval has elapsed. To use this function, AlazarBeforeAsyncRead must be called with the ADMA_ALLOC_BUFFERS flag.

**Syntax**

```
C/C++
RETURN_CODE
AlazarWaitNextAsyncBufferComplete(
   HANDLE  BoardHandle,
   void *Buffer,
   U32 BytesToCopy,
   U32 Timeout_ms
);
```

```
VisualBasic
AlazarWaitNextAsyncBufferComplete( _
      ByVal BoardHandle As Integer, _
      ByRef Buffer As Any, _
      ByVal BytesToCopy As Long, _
      ByVal Timeout_ms As Long _
) As Long
```

**Parameters**

*BoardHandle*

[in] Handle to board.

*Buffer*

[out] Pointer to a buffer to receive sample data from the digitizer board.

*BytesToCopy*

[in] The number of bytes to copy into the buffer.

*Timeout_ms*

[in] Specify the time to wait, in milliseconds, for the buffer to be filled.

**Return values**

If the board receives sufficient trigger events to fill the next available buffer before the timeout interval elapses, and the buffer is not the last buffer in the acquisition, the function returns ApiSuccess (512).

If the board receives sufficient trigger events to fill the next available buffer before the timeout interval elapses, and the buffer is the last buffer in the acquisition, the function returns ApiTransferComplete (589).

If the timeout interval elapses before the board receives sufficient trigger events to fill the next available buffer, the function returns ApiWaitTimeout (579).

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If the board overflows its on-board memory, the function returns ApiBufferOverflow (582). The board may overflow its on-board memory because the rate at which it is acquiring data is faster than the rate at which the data is being transferred from on-board memory to host memory across the host bus interface (PCI or PCIe). If this is the case, try reducing the sample rate, number of enabled channels, or amount of time spent processing each buffer.

If the function fails for some other reason, it returns an error code that indicates the reason that it failed. See Table 2 for a list of error codes.

**Remarks**

You must call AlazarBeforeAsyncRead with the ADMA_GET_PROCESSED_DATA flag before calling **AlazarWaitNextAsyncBufferComplete**.

To discard buffers, set the BytesToCopy parameter to zero. This will cause **AlazarWaitNextAsyncBufferComplete** to wait for a buffer to complete, but not copy any data into the application buffer.

To enable disk streaming using high-performance disk I/O functions, call AlazarCreateStreamFile before calling AlazarWaitNextAsyncBufferComplete. For best performance, set the BytesToCopy parameter to zero so that data is streamed to disk without making any intermediate copies in memory.

If AlazarBeforeAsyncRead is called with the ADMA_GET_PROCESSED_DATA flag, **AlazarWaitNextAsyncBuferComplete** will process buffers so that the data always appears in NPT format: R1A, R2A, … RnA, R1B, R2B, … RnB. This may simply you application, but it comes at the expense of added processing time for each buffer.

If AlazarBeforeAsyncRead is not called with the called with the ADMA_GET_PROCESSED_DATA flag set, then arrangement of sample data in a buffer depends on the AutoDMA mode.

**See Also**

AlazarAbortAsyncRead
AlazarBeforeAsyncRead
AlazarPostAsyncBuffer
Using asynchronous AutoDMA

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## 3.3 Error Codes

The following table lists the error codes that are returned by the API, their numerical values, and their descriptions. These error codes are declared in AlazarError.h.

**Table 2 Error Codes**

| Identifier | Value | Comment |
|---|---|---|
| ApiSuccess | 512 | The operation completed without error. |
| ApiFailed | 513 | The operation failed. |
| ApiAccessDenied | 514 | |
| ApiDmaChannelUnavailable | 515 | |
| ApiDmaChannelInvalid | 516 | |
| ApiDmaChannelTypeError | 517 | |
| ApiDmaInProgress | 518 | |
| ApiDmaDone | 519 | |
| ApiDmaPaused | 520 | |
| ApiDmaNotPaused | 521 | |
| ApiDmaCommandInvalid | 522 | |
| ApiDmaManReady | 523 | |
| ApiDmaManNotReady | 524 | |
| ApiDmaInvalidChannelPriority | 525 | |
| ApiDmaManCorrupted | 526 | |
| ApiDmaInvalidElementIndex | 527 | |
| ApiDmaNoMoreElements | 528 | |
| ApiDmaSglInvalid | 529 | |
| ApiDmaSglQueueFull | 530 | |
| ApiNullParam | 531 | |
| ApiInvalidBusIndex | 532 | |
| ApiUnsupportedFunction | 533 | |
| ApiInvalidPciSpace | 534 | |
| ApiInvalidIopSpace | 535 | |
| ApiInvalidSize | 536 | |
| ApiInvalidAddress | 537 | |
| ApiInvalidAccessType | 538 | |
| ApiInvalidIndex | 539 | |
| ApiMuNotReady | 540 | |
| ApiMuFifoEmpty | 541 | |
| ApiMuFifoFull | 542 | |
| ApiInvalidRegister | 543 | |
| ApiDoorbellClearFailed | 544 | |
| ApiInvalidUserPin | 545 | |
| ApiInvalidUserState | 546 | |
| ApiEepromNotPresent | 547 | |
| ApiEepromTypeNotSupported | 548 | |

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| Identifier | Value | Comment |
|---|---|---|
| ApiEepromBlank | 549 | |
| ApiConfigAccessFailed | 550 | |
| ApiInvalidDeviceInfo | 551 | |
| ApiNoActiveDriver | 552 | |
| ApiInsufficientResources | 553 | |
| ApiObjectAlreadyAllocated | 554 | |
| ApiAlreadyInitialized | 555 | |
| ApiNotInitialized | 556 | |
| ApiBadConfigRegEndianMode | 557 | |
| ApiInvalidPowerState | 558 | |
| ApiPowerDown | 559 | |
| ApiFlybyNotSupported | 560 | |
| ApiNotSupportThisChannel | 561 | |
| ApiNoAction | 562 | |
| ApiHSNotSupported | 563 | |
| ApiVPDNotSupported | 564 | |
| ApiVpdNotEnabled | 565 | |
| ApiNoMoreCap | 566 | |
| ApiInvalidOffset | 567 | |
| ApiBadPinDirection | 568 | |
| ApiPciTimeout | 569 | |
| ApiDmaChannelClosed | 570 | |
| ApiDmaChannelError | 571 | |
| ApiInvalidHandle | 572 | |
| ApiBufferNotReady | 573 | |
| ApiInvalidData | 574 | |
| ApiDoNothing | 575 | |
| ApiDmaSglBuildFailed | 576 | |
| ApiPMNotSupported | 577 | |
| ApiInvalidDriverVersion | 578 | |
| ApiWaitTimeout | 579 | The operation did not finish during the timeout interval.<br>Try the operation again, or abort the acquisition. |
| ApiWaitCanceled | 580 | |
| ApiBufferTooSmall | 581 | |
| ApiBufferOverflow | 582 | The board overflowed its on-board memory.<br>Try reducing the sample rate, reducing the number of enabled channels, increasing the size of each DMA buffer, or increasing the number of DMA buffers. |
| ApiInvalidBuffer | 583 | |

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| Identifier | Value | Comment |
|---|---|---|
| ApiInvalidRecordsPerBuffer | 584 | |
| ApiDmaPending | 585 | An asynchronous I/O operation was successfully started on the board. It will be completed when sufficient trigger events are supplied to the board to fill the buffer. |
| ApiLockAndProbePagesFailed | 586 | The driver or operating system was unable to prepare the specified buffer for a DMA transfer.<br>Try reducing the buffer size, or total number of buffers. |
| ApiWaitAbandoned | 587 | |
| ApiWaitFailed | 588 | |
| ApiTransferComplete | 589 | This buffer is the last in the current acquisition. |
| ApiPllNotLocked | 590 | A hardware error has occurred.<br>Contact AlazarTech. |
| ApiNotSupportedInDualChannelMode | 591 | The requested number of samples per channel is too large to fit in on-board memory.<br>Try reducing the number of samples per channel, or switching to single channel mode. |
| ApiNotSupportedInQuadChannelMode | 592 | The requested number of samples per channel is too large to fit in on-board memory.<br>Try reducing the num |
| ApiFileIoError | 593 | A file read or write error occurred. |
| ApiInvalidClockFrequency | 594 | The requested ADC clock frequency is not supported. |
| ApiError | 603 | The requested number of records in a single-port acquisition exceeds the maximum supported by the digitizer.<br>Use dual-ported AutoDMA to acquire more records per acquisition. |
| ApiError | 604 | The requested number of records in a single-port acquisition exceeds the maximum supported by the digitizer. |

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## 3.4 Glossary

| | |
|---|---|
| AutoDMA | AutoDMA is a hardware feature of AlazarTech digitizers. It allows the digitizer to store sample data to its on-board memory at the same time that it performs a DMA transfer from its on-board memory to host memory. |
| Continuous AutoDMA | Continuous is an AutoDMA mode that configures a digitizer to capture a continuous stream of sample data from one or more analog input channels. The digitizer splits the continuous stream of samples into segments, and transfers segments one at a time to host memory. There can be an infinte number of segments in one acquisition.<br>Trigger engines are disabled in continuous mode AutoDMA. The acquisition begins on a software command. |
| Dual-port memory | Dual-port memory on AlazarTech digitizers is RAM memory that allows simultaneous read and write operations. |
| Record | A record is a sequence of ADC values captured as a result of a trigger event. Records may contain sample values that occur both before and after a trigger event. |
| NPT AutoDMA | NPT is an AutoDMA mode that configures a digitizer to capture multiple records (one per trigger event) with no samples before the trigger event. It supports higher trigger rates than traditional AutoDMA mode. |
| Traditional AutoDMA | Traditional is an AutoDMA mode that configures a digitizer to acquire multiple records (one per trigger event) with samples before and after a trigger event, and optional record headers including timestamps. It supports lower trigger repeat rates than NPT mode. |
| Triggered streaming AutoDMA | Trigger streaming is an AutoDMA mode that configures a digitizer to capture a continuous stream of sample data from one or more analog input channels. The digitizer splits the continuous stream of samples into segments, and transfers segments one at a time to host memory. There can be an infinte number of segments in one acquisition.<br>Ttrigger engines are enabled in triggered streaming mode. The acquisition begins when the digitizer receives a trigger event. |

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